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A Register of Underwater Acoustic Facilities presents data accumulated during April through September 1985. A total of 40 sites in six countries are described: United Kingdom, Denmark, Norway, Netherlands, Germany, and Italy.

In the future, this register will be updated and new entries added. Specifically, it is anticipated that entires for facilities not yet visited will be added.

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1 March 1987

A Register of Underwater Acoustic Facilities

Vol. I: Western Europe

Office of the
Associate Technical Director
for Research and Technology

Naval Underwater Systems Center
Newport, Rhode Island / New London, Connecticut

PREFACE

This document describes the Underwater Acoustic Facilities at 40 different activities located in six Western European countries. The data reported here were collected during the period April through September 1985. Support for this effort was shared by the Office of Naval Research Branch Office, London, and the Naval Underwater Systems Center. Principal Investigator was F. G. Weigle (NUSC, Code 10) under the ONRL Liaison Technologist Program.

REVIEWED AND APPROVED: 1 March 1987

W.A. Von Winkle

W. A. VON WINKLE
ASSOCIATE TECHNICAL DIRECTOR FOR RESEARCH AND TECHNOLOGY

The author of this document is located at the
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New London, CT 06320.

TABLE OF CONTENTS

	Page
Subject Index	iii
Introduction	ix
Section 1. United Kingdom	1-1
A.R.E. Portland Laboratory	1-1
A.R.E. Portland CRYSTAL	1-9
A.R.E. Portland Noise Range	1-15
A.R.E. Teddington Laboratory	1-19
A.R.E. Teddington Loch Goil Range	1-29
A.R.E. Teddington Loch Fyne Range	1-33
A.R.E. Teddington Rona Range	1-39
J&S Marine, Ltd. (Barnstaple, North Devon)	1-51
Plessey Marine, Ltd. (Templecombe, Somerset)	1-57
Section 2. Denmark	2-1
Danish Defense Research Establishment (Copenhagen)	2-1
Søvaernets Taktikskolen (Copenhagen)	2-7
Søvaernets Materiel Kommando (Copenhagen)	2-9
Industrial Acoustics Laboratory (Lyngby)	2-11
Reson System ApS. (Hilleroed)	2-15
Brüel & Kjaer Laboratories (Naerum)	2-29
Danish Hydraulic Institute (Hørsholm)	2-35
Danish Maritime Institute (Lyngby)	2-43
Section 3. Norway	3-1
Aamøy Range (Stavanger)	3-1
NUTEC (Bergen)	3-9
IKU (Trondheim)	3-19
ELAB (Trondheim)	3-27
MARINTEK (Trondheim)	3-31
Norwegian Defense Research Establishment (Horten)	3-37
SIMRAD Subsea A/S (Horten)	3-47
Section 4. The Netherlands	4-1
Meetpost Noordwijk (North Sea, 5 nmi. off Noordwijk)	4-1
FEL-TNO Laboratory (The Hague)	4-5
FEL-TNO Nootdorp Lake Facility (Nootdorp)	4-13
TPD [TNO-TH] (Delft)	4-17
MARIN (Ede)	4-29
Section 5. Germany	5-1
E-71 Laboratory (Eckernförde)	5-1
E-71 Aschau Range (Aschau)	5-1
E-71 Plön Lake Facility (Plön)	5-13
FHAK Laboratory (Ottobrunn)	5-21
FHAK Ammersee Lake Facility (Ammersee)	5-25
FWG Laboratory (Kiel)	5-33
FWG PLANET (Kiel)	5-37
FWG North Sea Platform (In North Sea, 40 nmi. NW of Helgoland)	5-43

TABLE OF CONTENTS (Cont'd)

	Page
Section 6. Italy	6-1
Sarzana Lake Facility (Vicinity Lerici)	6-1
USEA SpA (Lerici)	6-5
Whitehead-Motofides, SpA	6-13
ELSAG (Genova-Sestri)	6-17
ELSAG (Fusaro, outside Naples)	6-27
Soc. FIAR (Milano)	6-37
CPE (Cinisello Balsalmo, outside Milano)	6-43
Section 7. SACLANTCEN	7-1
Center Laboratory (La Spezia)	7-1
Center Ship Operations	7-13
T-Boat MANNING	7-13
R/V MARIA PAOLINA G.	7-15
R/V ALLIANCE (Hull No. 921)	7-18

SUBJECT INDEX

	Page(s)
Acoustic Array Production and Calibration	1-51, 1-54, 2-4, 2-16, 3-38, 4-5, 4-10, 4-11, 4-13, 4-17, 6-1, 6-6
Acoustic Calibration/Measurement Barges and Other Floating Platforms.	1-9, 1-11, 1-13, 1-57, 1-62 - 1-66, 2-35, 3-9, 3-11, 3-12, 3-37, 3-38, 3-40, 3-41, 3-43 - 3-49, 4-1, 4-3, 4-10, 4-13, 4-14, 4-16, 5-1, 5-13, 5-17, 5-21, 5-25
Acoustic/Oceanographic Buoys.	2-4
Acoustic Ranges - Surface Ship.	1-15 - 1-17, 1-19, 1-29 - 1-32, 1-33 - 1-37, 1-39 - 1-50, 3-1 - 3-7, 5-1 - 5-11
- Submarine	1-29 - 1-32, 1-33 - 1-37, 1-39 - 1-50, 2-10, 3-1 - 3-7, 5-1 - 5-11
Acoustic Research Vessels	1-9, 1-11, 3-37, 3-38, 3-41, 3-43 - 3-47, 4-30, 5-21, 5-29 - 5-32, 5-33, 5-37 - 5-41, 7-13 - 7-27
Acoustic Transmissivity Measuring Facilities.	1-19, 5-23, 5-25, 5-27, 7-1
Acoustic Velocity Profilers, Velocimeters	1-42, 2-1, 2-4, 2-7, 4-29
Air Acoustic Facilities	1-5, 1-7, 5-13, 5-16
Anechoic Tanks.	1-1, 1-25, 1-26, 1-51 - 1-53, 2-11, 2-25, 4-6, 6-9
Anechoic Techniques	4-5, 4-25, 7-1
Bathymetric Sonars.	3-49
Buoys, Recording.	2-4, 3-19, 3-23, 3-24, 3-25, 6-6
Buoys, Telemetering	3-9, 3-10, 5-31, 5-32
Calibration Sites, Calibration Barges . .	1-9, 1-11, 1-57, 1-62 - 1-66, 2-15, 3-9 - 3-12, 3-41, 3-43, 3-47 - 3-49, 5-13 - 5-19, 6-5

SUBJECT INDEX (Cont'd)

	Page(s)
Calibration Tanks, Pools.	1-2, 1-5, 1-6, 1-19, 1-25, 2-12, 2-15, 2-17, 2-23, 2-24, 3-13, 3-27, 3-29, 3-37, 3-39, 3-40, 4-5, 6-5, 6-9, 6-27, 6-30, 6-36, 6-40, 6-45, 7-1
Cavitation Test Facilities.	1-24, 1-26, 2-44, 3-28, 3-31 - 3-34, 4-29, 5-29 - 5-31
Curing Ovens.	1-1, 1-3, 1-59, 3-50, 6-24, 7-9
Depressurized Cavitation Tank	4-29 - 4-32
Dome Test Facilities.	1-9, 1-11, 1-12
Echosounders.	2-17, 2-46, 3-28, 3-39, 3-49, 6-6
Environmental Testing - Aging Facilities.	6-24
- Climatic Chambers	1-57, 1-60, 6-5, 6-24, 6-41
- Humidity Chambers	6-12, 6-24, 6-41
- Ovens	6-12, 6-17, 6-24
- Refrigerated Chambers	6-12
- Salt Fog Testing.	6-17, 6-24
Fathometers	1-34, 1-35, 2-46, 5-40
Fisheries Acoustic Systems.	2-43, 3-28, 3-38, 3-39
Fixed Platforms with Acoustic Facilities.	3-27, 5-13 - 5-16, 5-33, 5-34, 5-43 - 5-52, 6-1
Hydrophone Calibrator	1-5, 1-7, 2-15, 2-17, 5-13, 5-16
Hydrophone/Transducer Calibration/Measurement Systems.	1-5 - 1-7, 1-19, 1-26, 1-51 - 1-54, 1-57, 1-59, 2-11, 2-23, 2-24, 2-29 - 2-31, 4-13, 5-13 - 5-19, 6-11, 6-36, 6-40, 7-12

SUBJECT INDEX (Cont'd)

	Page(s)
Hydrophone/Transducer Calibration with Pistonphone and Related Devices . . .	1-5, 1-7, 3-43 - 3-52, 5-13 - 5-19, 6-12
Hydrophone/Transducer Calibration Sites .	1-5 - 1-7, 1-19, 1-25, 1-51 - 1-54, 2-9, 2-15, 2-17, 2-23, 4-8, 6-1 - 6-3, 6-43, 7-7
- Lakes	1-62 - 1-66, 4-5, 4-13, 5-13 - 5-19, 5-25, 6-1 - 6-3
- Open Water Barges	3-47 - 3-49, 4-13, 4-14
- Special Vessels	1-11, 1-12, 3-37, 3-39, 3-41, 3-43 - 3-47
Hydrophone/Transducer Calibration under Pressure.	1-5, 1-6, 1-25
Hydrophone/Transducer Man-Made Calibration Tanks and Pools	1-5, 1-6, 6-45, 6-46
In-Air Calibration Systems.	1-5, 1-7, 5-13, 5-16
Instrument Containers (Transportable) . .	4-5, 4-10, 6-16
Machine Shop Facilities	1-51, 1-58, 5-14, 5-21, 5-22, 5-43, 6-17, 6-23, 6-34, 6-40, 7-1, 7-7
Meteorology	1-44, 2-35, 5-33, 5-34, 5-37, 5-43, 5-46
Mobile (Transportable) Calibration/ Measurement Systems	2-24, 5-1, 5-11, 6-27, 6-39, 6-40, 6-43
Noise Measurement Ranges.	1-15, 1-16, 1-29 - 1-32, 1-33 - 1-37, 1-39 - 1-50, 2-2, 3-1 - 3-7, 4-18, 4-25, 4-26, 5-1 - 5-11
Pistonphones and Related Calibration Devices	1-5, 1-7, 2-17, 3-45, 3-50 - 3-52, 5-13, 5-16, 6-12

SUBJECT INDEX (Cont'd)

	Page(s)
Power Amplifiers.	1-3, 1-13, 1-27, 1-42, 1-60, 1-64, 3-27, 3-30, 3-49, 6-24, 6-47, 7-1, 7-7, 7-13
Pressurized Acoustic Test Vessels	1-5, 1-6, 1-57, 1-60, 1-61, 2-15, 2-17, 4-8, 4-10, 6-5, 6-9, 6-17, 6-24, 7-1, 7-8
Pressure Test Vessels (Non-Acoustic). . .	1-1 - 1-3, 1-60, 2-19 - 2-21, 3-9
Pulse Impedance Tube Measuring Devices. .	1-5, 1-6
Ranges, Radiated Ship Noise	1-29 - 1-31, 1-33 - 1-37, 1-39 - 1-50, 3-1 - 3-7, 5-1 - 5-11, 6-8
Remote Platforms, Towers.	5-33, 5-36, 5-43 - 5-52, 6-1
Resilient Mounting Test Equipment	4-22, 4-25
Reverberant Tank (For Ship Noise Studies)	4-17, 4-18, 4-22, 4-26, 4-29
Rotating Beam/Circular Water Channel. . .	1-19, 1-21, 1-22
Shakers	1-1, 1-3, 1-57, 1-60, 4-18, 4-20, 5-26, 6-12, 6-17, 6-24, 7-9
Ship Model Shops.	2-43, 2-46, 4-17, 4-20, 4-29, 4-32, 4-35
Ship Model Towing Tanks	2-44, 3-31 - 3-36, 4-29 - 4-32
Shock/Vibration Test Facilities	1-1, 1-3, 6-8, 6-12, 6-24, 6-37, 6-43, 6-46
Side Looking Sonars	1-54, 2-23, 2-46, 3-20, 3-23, 7-10
Sonar - Dome Testing Facilities	1-5, 1-9, 1-12, 6-23
Sonar Repair and Refurbishment Facilities	1-51, 1-54
Sonar System Manufacturing Facilities . .	3-28, 3-29, 6-6, 6-8, 6-17, 6-18, 6-23, 6-27, 6-37
Board Wiring Machines	6-25
Board Washing Facilities.	6-25

SUBJECT INDEX (Cont'd)

	Page(s)
Wave Soldering Machines	6-25, 6-36, 6-42
Structure-Borne Noise Measurement Facilities.	5-23, 5-25 - 5-27
Submersibles.	1-33, 3-9, 3-11 - 3-16, 6-22
Torpedo Array Construction.	6-14, 6-17, 6-19
Torpedo Array Test Facilities	6-8, 6-13 - 6-16, 6-17, 6-42
Towed Array Production.	1-51, 1-54, 4-11
Towed Array Measurement Facilities. . . .	4-11
Towing Tanks.	2-43, 2-44, 2-46, 3-31, 3-33, 3-34, 4-30 - 4-32
Transducer Repair Facilities.	1-51 - 1-55
Transducer Production & Development . . .	6-5, 6-6, 6-10, 6-44, 7-1
Ultrasonics - Element Production.	2-12, 2-15, 2-16
Underwater Inspection	3-23, 4-17, 4-20, 4-22
Velocimeters (Acoustic Velocity Profilers).	1-42, 2-1, 2-4, 2-7, 2-27, 3-28, 4-29
Water Wave Generators	1-25, 2-43, 2-44, 3-31, 3-35
Water Wave Test Basins (Tanks).	2-11, 2-43, 3-31, 3-33
Water Tunnels	1-19, 1-24 - 1-26
Wind Tunnels.	1-19, 1-21, 1-23, 1-24, 2-43, 2-46

INTRODUCTION

The data included in the following Register of Underwater Acoustic Facilities were collected during visits to forty different activities in the period 1 April to 26 September 1985.

While the Register is intended primarily for the use of the U.S. Navy, it is unclassified and is available to all the participating activities in each country visited.

Responsibility and the necessary support for the preparation and production of this Register was shared between the Office of Naval Research, Branch Office, London, and the Naval Underwater Systems Center, New London.

The activities which were visited are listed below.

Facility	Contact	City	Country
A.R.E. (Admiralty Research Establishment)	R. Gale	Portland	England
Reson Systems, ApS.	P. Steenstrup	Hilleroed	Denmark
DTH (Technical Univ. of Denmark)	L. Bjørnø	Lyngby	Denmark
Danish Defense Research Establishment	Tage Strarup	Copenhagen	Denmark
Søvaernets Taktikskole	Capt. Grentzman	Copenhagen	Denmark
Søvaernets Material Kommando	T. Munk	Copenhagen	Denmark
DHI (Danish Hydraulic Institute	H. Meister	Hørsholm	Denmark
Brüel & Kjaer	O. Oleson	Naerum	Denmark
DMI (Danish Maritime Institute)	G. Rodenhuis	Lyngby	Denmark
A.R.E. (Admiralty Research Establishment)	G. Knight	Teddington	England
FEL-TNO (Physics and Elec. Lab.)	H. Rijnja	The Hague	Netherlands
TNO-TH (Institute of Applied Physics)	A. de Bruijn	Delft	Netherlands
Meetpost Noordwijk (Aborted)	A. Koeman	Rijswijk	Netherlands

Facility	Contact	City	Country
MARIN (Maritime Research Institute)	J. Ligtelijn	Ede	Netherlands
J&S Marine, Ltd.	D. Cullen	Barnstaple	England
E71	H. Arens	Eckernförde	W. Germany
E71 Calibration Facility	Messrs. Bachor & Krüger	Plön	W. Germany
FHAK (Fraunhofer-Forschungsgruppe für Hydroakustik)	K. Albrecht	Ottobrunn	W. Germany
FWG (Forschungsanstalt der Bundeswehr für Wasserschall and Geophysik)	G. Ziehm	Kiel	W. Germany
FWG Research Vessel PLANET	Messrs. Ziehm & Schmidt	Kiel	W. Germany
FWG North Sea Platform Installation	Messrs. Ziehm & Pieper	Kiel	W. Germany
Plessey Marine Research Unit	P. Burr	Templecombe	England
Aamøy Noise Range	Mr. Mjölsnes	Stavanger	Norway
NUTEC (Norwegian Underwater Technology Center	A. Lundblad/ K. Andersen	Bergen	Norway
IKU (Institutt for Kontinental-Sokkel Undersøkelser og Petroleumsteknologia A/S)	J. Hovem	Trondheim	Norway
ELAB (Elektronikklaboriet ved NTH)	J. Dalen/ T. Reinen	Trondheim	Norway
MARINTEK (Norwegian Marine Technology Research Institute A/S)	K. Holden/ P. Werenskiold	Trondheim	Norway
SIMRAD Subsea A/S	H.J. Alker/ T. Helland	Horten	Norway
NDRE (Norwegian Defense Research Establishment)	E. Kjellsby	Horten	Norway

Facility	Contact	City	Country
Loch Goil Noise Range	Group Leader in ARE Teddington: D. Fraser; OIC at Loch Goil: J. Revie	Loch Goilhead	Scotland
Loch Fyne Noise Range	Fraser & Revie as above	Loch Fyne	Scotland
Is. of Rona Noise Range	G. Knight at ARE Teddington; D. McGee, RCA Contractor on-site	Kyle of Lochalsh	Scotland
SACLANTCEN	R. Goodman/ C. Walsh	La Spezia	Italy
Sarzana Lake Calibration/ Measurement Facility	Col. E. Diamanti (MARIPERMAN)	Sarzana	Italy
SACLANT R/V Maria Paolina G.	C. Walsh	La Spezia	Italy
New Research Vessel (Muggiano Shipyard) Hull 921	T. Cummings	La Spezia	Italy
USEA (Ufficio Studio Elletro Acoustica)	G. Vettori	Lerici	Italy
Whitehead-Motofides SpA.	Messrs. Galletti & Scardigli	Livorno	Italy
ELSAG SG (Elettronica San Giorgio)	L. Balzarini	Genova	Italy
ELSAG-Fusaro (Naval Systems Division)	Capt. N. Ricciardi	Napoli	Italy
Soc. FIAR (Fabbrica Italiana Apparecchiature Radioelettriche SpA.)	I. Bertelli	Milano	Italy
CPE (Centro Projettazioni Elettronica	Drs. Latini & Gasparini	Milano	Italy

It was determined at the outset of this effort that the Register would be of maximum usefulness in the form of a looseleaf document, capable of being updated and of receiving additional entries in the future. Specifically, it is intended that entries for facilities in countries not yet visited will be added (as, most certainly, the appropriate facilities in Canada).

Requests for additional copies of this Register as well as queries or comments concerning modifications of, additions to, or deletions from the document should be directed to

Associate Technical Director for Technology
Code 10
NUSC New London Laboratory
New London, CT 06320

Date of this Summary
10 April 1985

Facility Name: A.R.E. Transducer Development Laboratory

Location: At A.R.E. (North) on the Isle of Portland

Cognizant Organization: Admiralty Research Establishment

Facility Functional Name: Transducer Development Laboratory

Major User(s): Royal Navy, Royal Navy contractors and A.R.E.

Technical Areas Supported: Royal Navy sonar system developments, noise range improvements and special measurements for Royal Navy contractors, improved measurement systems for CRYSTAL

Unique Features: The anechoic calibration tank has two shafts, both of which are rotatable and both of which can be moved in X, Y, and Z directions. The shaft positions in turn can be computer controlled. A computer program has been written which allows the measurement system to run unattended with the transmit shaft occupying a series of random positions. The received pseudo random noise (PRN) signals are summed for all positions and the average received signal obtained. The result is effectively free of reflections and permits use of the tank at frequencies lower than customary by an order of magnitude.

Significant Equipment Available: Anechoic calibration tank; four large static pressure tanks; shaker table; chemistry lab; degreasing, liquid sand-blasting, ultrasonic cleaning facilities; oil filling facilities (under vacuum), curing ovens; all standard electronic bridges, measurement and test equipment, amplifiers; and HP computers, plotters and printers

Local Environment: Housed at the Royal Navy Base on the Isle of Portland. The base is located outside the town center of Portland and acoustically is moderately quiet.

Future Plans for Facility: No major changes contemplated.

Facility Mailing Address: Admiralty Research Establishment
Portland, Dorset DT5 2JS
U.K.

Local Contacts: Head, A.R.E. Sonar Dept.
A.R.E., Portland, Dorset
Tel: 0305-820311

Contact for Access/Scheduling:
Head, A.R.E. Transducer Group
A.R.E. Portland, Dorset
Tel: 0305-820311 Ext. 3481

Narrative Description: The key facility in the A.R.E. Transducer Development Laboratory is the open measurement tank with associated equipment. The tank

Narrative Description (Cont'd):

measures 18 x 8 x 8 ft. deep (5.5 x 2.4 x 2.4 m.). It is lined with Fafnir spikes throughout and is anechoic (nominally) above 3 kHz.

The operation of the tank is automated, and a number of computers (generally HP) are used in this connection along with plotters, printers, filters and other digital and hybrid peripherals.

The block diagram and rack layout of the system in use is shown below in Figures 1-1 and 1-2. This is the system which is intended for use on CRYSTAL as well. It is expected that a total of six such systems will be assembled--five for CRYSTAL and one to be retained in the Transducer Development Laboratory.

There are two shafts in this measurement tank, both of which are movable in X, Y, and Z directions, both are rotatable while neither is concentric.

One noteworthy innovation is that mentioned earlier which through programmed computer control of the shaft (source and/or receiver) position in X, Y, and Z, allows the separation distance and the distances from the reflecting boundaries to be varied in a random manner. Pseudorandom noise pulses are transmitted in each position and the received signals are summed for all positions and averaged. The result is a received signal effectively free of interference due to reflections which in turn permits use of the tank at frequencies in the low hundreds of Hz vice the 3 kHz limitation normally encountered. (An A.R.E. Portland publication describing this capability in detail is currently in preparation according to R.D. Gale, current Head, A.R.E. Transducer Group.)

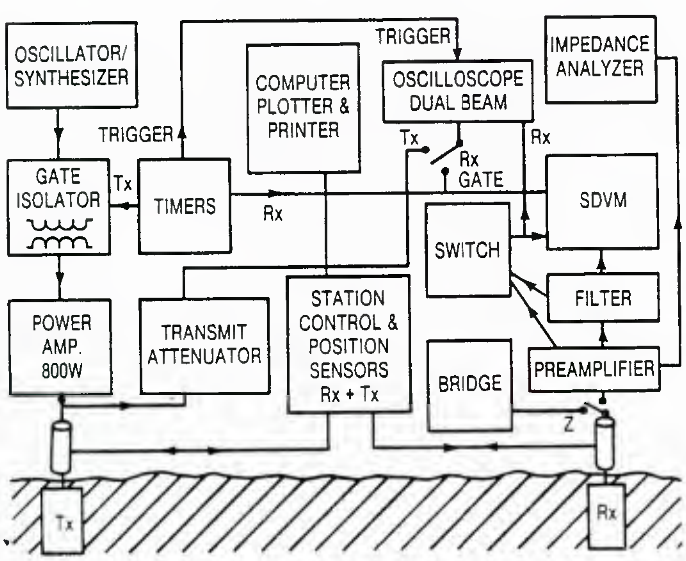


Figure 1-1. Basic Measurement System--Block Diagram

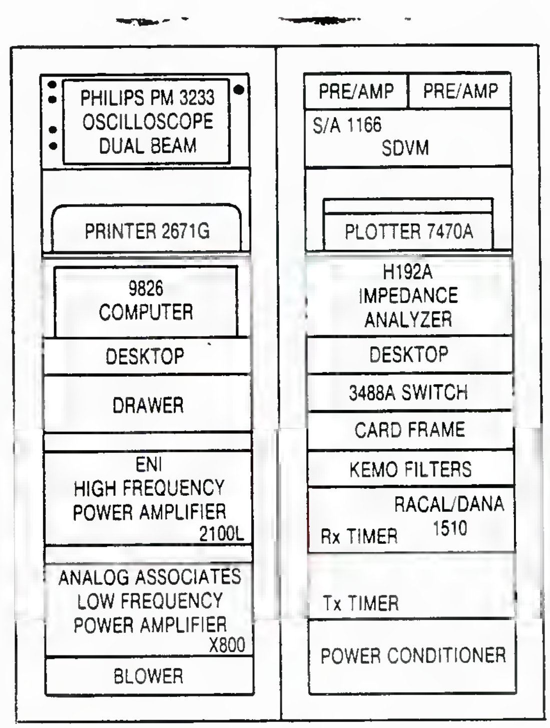


Figure 1-2. Basic Measurement System--Rack Layout

Narrative Description (Cont'd):

A modest chemistry laboratory is part of the Transducer Laboratory which includes, among other items, the necessary facilities for fabricating transducers: a degreasing capability which includes ultrasonic cleaning facilities, a liquid sand-blasting facility, facilities for oil filling under vacuum, three curing ovens and one high-temperature oven for silvering ceramics.

A shaker table is located in an inner soundproofed room provided with armor-plated (bullet proof) glass viewing window and a concrete bed. The shaker system itself is a Derritron Electronics Ltd. Vibration Test Assembly with a 2 x 2 ft. (0.6 x 0.6 m.) horizontal granite block shake table. (Note that A.R.E. Portland also operates, at locations other than the Transducer Laboratory, a much larger shake and vibration facility, as well as a comprehensive environmental testing facility and an explosive shock testing facility.)

The Transducer Laboratory also includes several static high-pressure test vessels. These pressure vessels, which can not be used for acoustic measurements, are located in a separate building outside the Transducer Laboratory proper for purposes of safety. There are four tanks, two of which have a 0-3000 psi/0-204.1 bars pressure capability and have a 21-inch/53.3 cm. inside diameter and an internal length of 45 inches/114.3 cm. Two smaller tanks have a 0-5000 psi/0-340.1 bars pressure capability with a 9-inch/22.9 cm. inside diameter and a 30-inch/76.2 cm. internal length.

For higher power transducer testing, there are a number of Analog Associates 800-watt (Mod X-800B) Driver Amplifiers available, permitting a total power capability of 12 kW with large matching transformers. There is also a smaller A.R.E.-built 5 kA (5 kV) amplifier available.

For smaller vibration problems, a small Brüel & Kjaer Shaker System (Type 4809) is available.

Other equipments available include an HP 9845B with disc drives, an HP 9836 computer, an HP 5420A Analyzer, a Spectral Dynamics SD 375 Analyzer, several Solatron 1250 Frequency Response Analyzers with Plotters (Bryan 26000) and a Dranetz Model 100 Vector Impedance Meter.

As would be expected for such a well-equipped laboratory, an excellent selection of high quality standard test equipment, including filters, meters, bridges, oscilloscopes, printers, plotters and amplifiers is also available.

Other Information Sources: "A.U.W.E. Acoustic Calibration Facilities," A.U.W.E. Publication 42355, Oct. 1976, by R.J. Gale.

Date of this Summary
10 April 1985

Facility Name: A.R.E. Transducer Calibration Laboratory

Location: At A.R.E. (North) on the Isle of Portland

Cognizant Organization: Admiralty Research Establishment

Facility Functional Name: Calibration Laboratory

Major User(s): Royal Navy and contractors

Technical Areas Supported: Royal Navy sonar systems measurements and calibration, Royal Navy noise ranges, tracking ranges, hydrophone/projector development

Unique Features: Capability to calibrate hydrophones/projectors over an extremely wide frequency range: 10 Hz to 1 MHz. (Can perform some measurements up to frequencies in the vicinity of 10 MHz.)

Significant Equipment Available: Large Pulse Impedance Tube, 500 psi/34 bars Pressure Vessel (with two Rotatable Shafts), Low Frequency Air Pistonphone, Electrostatic Hydrophone Calibrator, High Frequency Open Calibration Tank

Local Environment: Housed on the Royal Navy Base on the Isle of Portland. The base is located outside the town center of Portland and acoustically is moderately quiet.

Future Plans for Facility: No major changes contemplated. The Pulse Impedance Tube System will be refurbished in the near future.

Facility Mailing Address: Admiralty Research Establishment
Portland, Dorset DT5 2JS
U.K.

Local Contacts: Head, A.R.E. Sonar Dept.
A.R.E., Portland, Dorset
Tel: 0305-820311

Contact for Access/Scheduling:
Head, A.R.E. Transducer Group
A.R.E. Portland, Dorset
Tel: 0305-820311 Ext. 3481 or Ext. 3050

Narrative Description: The A.R.E. Transducer Calibration Laboratory is a versatile acoustic facility for the measurement of a wide range of properties of transducers and arrays and of sonar domes, windows and baffles.

The frequency range extends approximately from 10 Hz to 5 MHz. The specific frequency ranges of a variety of routine measurements are indicated in Figure 1-3.

Narrative Description (Cont'd):

Included among the devices and facilities used for such measurements is an open rectangular unlined tank, measuring 8 x 6 x 6 ft. deep/2.4 x 1.8 x 1.8 m. deep. There are two shafts, both of which are fixed in X-Y position and both of which are adjustable in depth. Only one of the two shafts is rotatable. This tank is used only at frequencies above 50 kHz and normally the signals used are pulses of such short duration that reflections do not constitute a problem.

Another capability is that of performing some calibrations and measurements under pressure up to 500 psi/34 bars in a limited frequency band. Measurements are limited to a lower frequency of 10 kHz where far field measurements are required or to 3 kHz where near field measurements are acceptable. A sketch of the pressure vessel is given in Figure 1-4 on the following page. Note that, of course, both shafts are fixed in X-Y position, but that both shafts are rotatable under pressure.

The capability of making impedance measurements of acoustic materials is provided through use of a pulse-tube. This particular pulse-tube was originally a section of destroyer propeller shaft. The tube is 15 ft./4.6 m. long and has a 15-in./38.1-cm. bore. It is capable of working inside pressures of 1000 psi/68 bars and is filled with filtered, de-ionized water. It is possible to traverse the probe hydrophone over the entire length of the tube to investigate standing wave patterns, if desired. (The pulse-tube is not currently in operation but can quickly be made operative. It is planned to perform a total refurbishment of the pulse-tube system in the near future.)

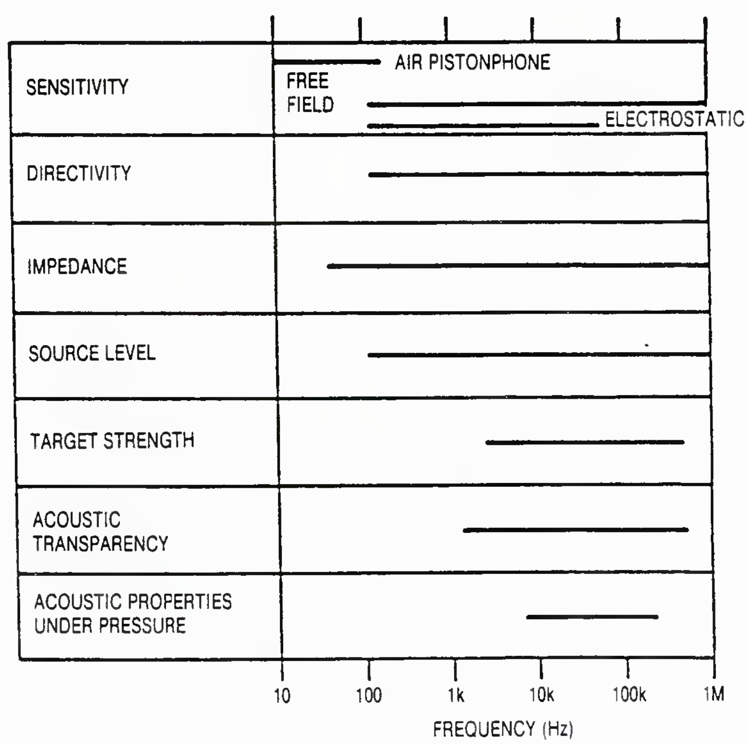


Figure 1-3. Frequency Range of Acoustic Measurements

Narrative Description (Cont'd):

Another device, for measuring sensitivities at low frequencies, is a large Air Pistonphone. This particular device can accept hydrophones up to about 8 in./ 20.3 cm. diameter and sensitivities in the frequency range 10-200 Hz can be measured. In this unit, the hydrophone is suspended within the vessel from the top and a piston is sinusoidally driven below the hydrophone. The piston displacement is visually determined by measuring the vertical motion of the rod driving the piston. The volume change is then calculated and the absolute pressure variation obtained. For these dimensions and at these frequencies, the receiving sensitivities of the hydrophones under test will be the same in water as in air.

One final device available at the Transducer Calibration Laboratory is another in-air calibrator; in this case, an electrostatic calibrator. This unit allows the absolute calibration of elements with planar metallic piston heads not exceeding a 5-in./12.7-cm. diameter. The calibrator consists of a flat metal plate which is connected to the high side of a high-voltage (500 volts RMS) oscillator. The element under test is held (locked) in position close to the calibrator plate with its planar metallic head parallel to the calibrator plate. The field generated between the two parallel metallic plates provides the calibration pressure.

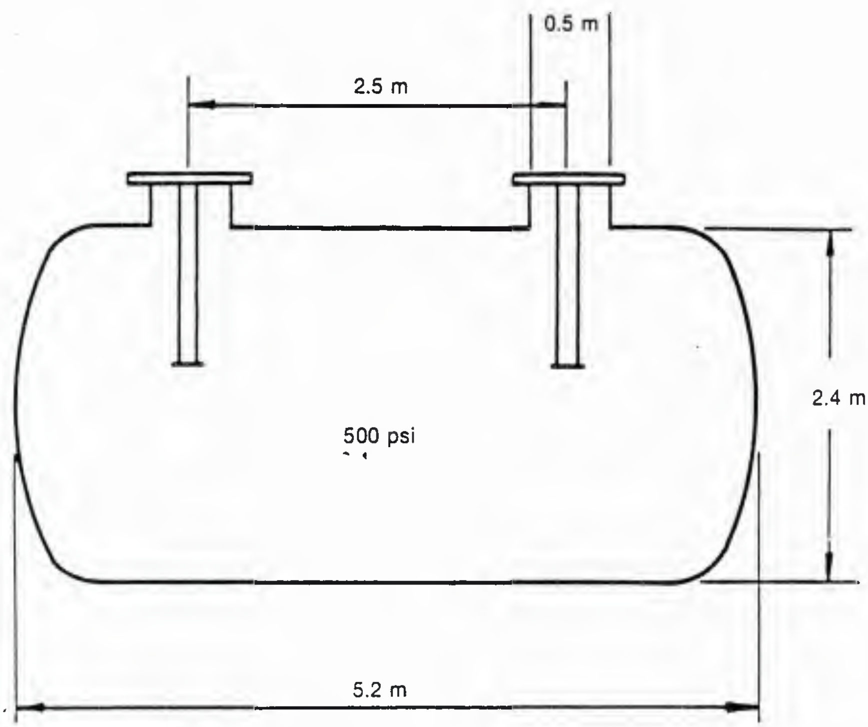


Figure 1-4. Pressure Test Vessel

Date of this Summary
10 April 1985

Facility Name: R.D.V. CRYSTAL

Location: Portland Harbor, A.R.E. North
Portland, Dorset (UK)

Cognizant Organization: Admiralty Research Establishment

Facility Functional Name: Calibration/Test Barge

Major User(s): Royal Navy

Technical Areas Supported: Sonar array measurement and calibration

Special Programs Supported: Originally built to accommodate MATTAPAN array but never used for that purpose.

Unique Features: Ability to handle large, heavy sonar arrays. Maximum onboard test distance of 332 ft./101 m. At the Heavy Station the concentric shaft maximum combined weight capability is 145 US tons/129.5 British tons and maximum array dimension approximately 60 ft./18 m.

Significant Equipment Available: There are a total of twenty-one (shaft) test positions (see Figure 1-5). Rotational angles and signals from each shaft can be monitored at the interior laboratory space. 10-US ton/8.9-British ton crane at forward Dome Test Station. 15-US ton/13.4-British ton crane at aft Heavy Station. Six 800-watt amplifiers used singly or in combination. Fiberglass pressure tank, 1000 psi/68 bars, approximately 4 ft./1.2 m. diameter, 5 ft./1.5 m. high and 16 in./40.6 cm. diameter opening. One fully computerized measurement set and several analog (S.A.) sets.

Local Environment: Portland Harbor water depth beneath CRYSTAL is approximately 60 ft. ± 3 ft./18 m. ± 0.9 m. Tidal flow is less than 0.5 kt. and the depth change is normally 3-4 ft./0.9-1.2 m. The harbor is well protected, but harbor traffic very occasionally necessitates night work for low frequency or low level measurements. There is very little barge motion. There is no fresh water influx and the harbor is described as homogeneous with constant salinity.

Future Plans for Facility: It is intended that the one preliminary computerized test set be upgraded with an HP 9826 computer and that four more computerized test sets be added to replace the analog equipment still in use.

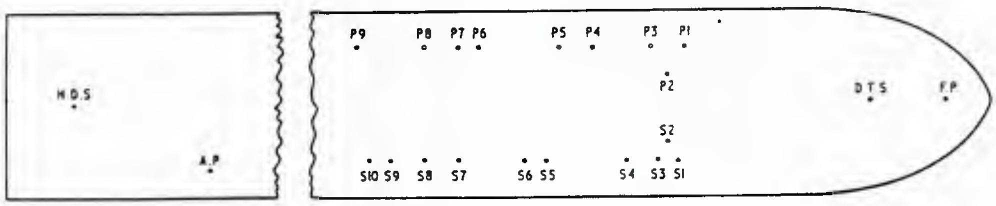
Facility Mailing Address: Admiralty Research Establishment
Portland, Dorset DT5 2JS
U.K.

Local Contacts: Head, A.R.E. Sonar Dept.
A.R.E., Portland, Dorset
Tel: 0305-820311

R.D.V. CRYSTAL

STATION DISTANCES AND ATTENUATIONS

TWIN SHAFT STATIONS P5 S9
D T S 25 TONS
H D S 120 TONS
F P, A P 1 TON PROBES



STATIONS	DISTANCE FT	ATT dBs
P1 P2	10.01	10.5
P1 P3	10.01	10.5
P1 P4	26.98	19.1
P1 P5	36.98	21.8
P1 P6	61.00	26.2
P1 P7	66.98	27.0
P1 P8	76.98	28.2
P1 P9	96.98	30.2
P1 S1	34.02	21.1
P1 S2	29.19	19.8
P1 S3	34.90	21.3
P1 S4	38.00	22.1
P1 S5	53.27	25.0
P1 S6	58.01	25.7
P1 S7	75.15	28.0
P1 S8	84.18	29.0
P1 S9	93.42	29.9
P1 S10	99.02	30.4
P1 HDS	257.21	38.7
P1 AP	167.07	34.9
P1 DTS	56.56	25.5
P1 FP	77.35	28.2
P2 P3	9.99	10.5
P2 P4	23.61	17.9
P2 P5	33.11	20.9
P2 P6	56.64	25.5
P2 P7	62.56	26.4
P2 P8	72.48	27.7
P2 P9	92.37	29.8
P2 S1	25.47	18.6
P2 S2	20.10	16.5
P2 S3	25.49	18.6
P2 S4	28.01	19.4
P2 S5	44.02	23.3
P2 S6	49.04	24.3
P2 S7	66.98	27.0
P2 S8	76.33	28.1
P2 S9	85.82	29.1
P2 S10	91.56	29.7
P2 HDS	251.77	38.5
P2 AP	160.54	34.6
P2 DTS	59.55	26.0
P2 FP	80.91	28.6
P3 P4	16.97	15.1
P3 P5	26.97	19.1
P3 P6	50.99	24.6
P3 P7	56.97	25.6
P3 P8	66.97	27.0
P3 P9	86.97	29.2
P3 S1	34.88	21.3
P3 S2	29.19	19.8
P3 S3	34.03	21.1
P3 S4	34.68	21.3
P3 S5	46.00	23.7
P3 S6	50.24	24.5
P3 S7	66.38	26.9
P3 S8	75.13	28.0
P3 S9	84.17	29.0
P3 S10	89.68	29.5
P3 HDS	247.23	38.3
P3 AP	157.29	34.4
P3 DTS	66.17	26.9
P3 FP	87.14	29.3
P4 P5	10.00	10.5
P4 P6	34.02	21.1
P4 P7	40.00	22.5
P4 P8	50.00	24.4
P4 P9	70.00	27.4
P4 S1	42.13	23.0
P4 S2	36.19	21.6
P4 S3	38.90	22.3
P4 S4	35.38	21.4
P4 S5	36.76	21.8
P4 S6	39.44	22.4
P4 S7	52.52	24.9
P4 S8	60.48	26.1
P4 S9	68.99	27.2
P4 S10	74.26	27.9
P4 HDS	230.30	37.7
P4 AP	140.78	33.4
P4 DTS	82.69	28.8
P4 FP	103.84	30.8
P5 P6	24.02	18.1
P5 P7	30.00	20.0
P5 P8	40.00	22.5
P5 P9	60.00	26.0
P5 S1	48.72	24.2
P5 S2	43.00	23.1
P5 S3	44.64	23.5
P5 S4	39.38	22.4
P5 S5	34.20	21.1
P5 S6	35.42	21.4
P5 S7	45.35	23.6
P5 S8	52.51	24.9
P5 S9	60.48	26.1
P5 S10	65.52	26.8
P5 HDS	220.33	37.3
P5 AP	131.11	32.8
P5 DTS	92.50	29.8
P5 FP	113.72	31.6
P6 P7	5.98	6.0
P6 P8	15.98	14.5
P6 P9	35.98	21.6
P6 S1	68.04	27.1
P6 S2	62.93	26.4
P6 S3	62.93	26.4
P6 S4	55.54	25.4
P6 S5	39.38	22.4
P6 S6	36.72	21.8
P6 S7	34.48	21.2
P6 S8	37.54	21.9
P6 S9	42.78	23.1
P6 S10	46.66	23.8
P6 HDS	196.38	36.3
P6 AP	108.12	31.1
P6 DTS	116.19	31.8
P6 FP	137.51	33.2
P7 P8	10.00	10.5
P7 P9	30.00	20.0
P7 S1	73.28	27.8
P7 S2	68.31	27.1
P7 S3	68.05	27.1
P7 S4	60.39	26.1
P7 S5	42.73	23.1
P7 S6	39.40	22.4
P7 S7	33.96	21.1
P7 S8	35.42	21.4
P7 S9	39.44	22.4
P7 S10	42.79	23.1
P7 HDS	190.43	36.1
P7 AP	102.47	30.7
P7 DTS	122.11	32.2
P7 FP	143.45	33.6
P8 P9	20.00	16.5
P8 S1	82.28	28.8
P8 S2	77.49	28.2
P8 S3	76.87	28.2
P8 S4	68.89	27.2
P8 S5	49.45	24.3
P8 S6	45.29	23.6
P8 S7	35.38	21.4
P8 S8	33.96	21.1
P8 S9	35.42	21.4
P8 S10	37.55	21.9
P8 HDS	180.47	35.6
P8 AP	93.12	29.8
P8 DTS	132.02	32.9
P8 FP	153.38	34.2
P9 S1	100.83	30.5
P9 S2	96.35	30.1
P9 S3	95.23	30.0
P9 S4	86.85	29.2
P9 S5	65.44	26.8
P9 S6	60.41	26.1
P9 S7	45.27	23.6
P9 S8	39.39	22.4
P9 S9	35.39	21.4
P9 S10	34.18	21.1
P9 HDS	160.57	34.6
P9 AP	74.91	27.9
P9 DTS	151.87	34.1
P9 FP	173.28	35.2
S1 S2	5.99	6.0
S1 S3	5.98	6.0
S1 S4	15.00	14.0
S1 S5	39.00	22.3
S1 S6	44.98	23.5
S1 S7	65.00	26.7
S1 S8	74.99	28.0
S1 S9	84.99	29.0
S1 S10	90.98	29.6
S1 HDS	255.19	38.6
S1 AP	161.43	34.6
S1 DTS	58.49	25.8
S1 FP	79.33	28.4
S2 S3	6.01	6.0
S2 S4	13.10	12.8
S2 S5	36.39	21.7
S2 S6	42.32	23.0
S2 S7	62.24	26.3
S2 S8	72.20	27.6
S2 S9	82.17	28.8
S2 S10	88.15	29.4
S2 HDS	251.92	38.5
S2 AP	158.55	34.5
S2 DTS	60.12	26.0
S2 FP	81.33	28.7
S3 S4	9.02	9.6
S3 S5	33.02	20.8
S3 S6	39.00	22.3
S3 S7	59.02	25.9
S3 S8	69.01	27.2
S3 S9	79.01	28.4
S3 S10	85.00	29.0
S3 HDS	249.23	38.4
S3 AP	155.45	34.3
S3 DTS	64.24	26.6
S3 FP	85.19	29.1
S4 S5	24.00	18.1
S4 S6	29.98	20.0
S4 S7	50.00	24.4
S4 S8	59.99	26.0
S4 S9	69.99	27.4
S4 S10	75.98	28.1
S4 HDS	240.23	38.1
S4 AP	146.43	33.8
S4 DTS	72.98	27.7
S4 FP	94.04	29.9
S5 S6	5.98	6.0
S5 S7	26.00	18.8
S5 S8	35.99	21.6
S5 S9	45.99	23.7
S5 S10	51.98	24.8
S5 HDS	216.30	37.2
S5 AP	122.43	32.2
S5 DTS	96.48	30.1
S5 FP	117.73	31.9
S6 S7	20.02	16.5
S6 S8	30.01	20.0
S6 S9	40.01	22.5
S6 S10	46.00	23.7
S6 HDS	210.34	36.9
S6 AP	116.45	31.8
S6 DTS	102.38	30.7
S6 FP	123.65	32.3
S7 S8	9.99	10.4
S7 S9	19.99	16.5
S7 S10	25.98	18.8
S7 HDS	190.39	36.1
S7 AP	96.43	30.1
S7 DTS	122.16	32.2
S7 FP	143.51	33.6
S8 S9	10.00	10.5
S8 S10	15.99	14.5
S8 HDS	180.44	35.6
S8 AP	86.44	29.2
S8 DTS	132.06	32.9
S8 FP	153.43	34.2
S9 S10	5.99	6.0
S9 HDS	170.49	35.1
S9 AP	76.44	28.1
S9 DTS	141.99	33.5
S9 FP	163.37	34.7
S10 HDS	164.53	34.8
S10 AP	70.45	27.4
S10 DTS	147.93	33.9
S10 FP	169.33	35.0
HDS AP	94.84	30.0
HDS DTS	310.60	40.3
HDS FP	332.12	40.9
AP DTS	218.11	37.2
DTS FP	21.52	17.1

Figure 1-5. R.D.V. CRYSTAL Station Distances and Attenuations

<u>Contact for Access/Scheduling</u>: Requests for use of CRYSTAL should be addressed to: Senior Scientist
R.D.V. CRYSTAL
A.R.E. Portland, Dorset DT5 2JS

<u>Narrative Description</u>: R.D.V. CRYSTAL is a large sonar transducer/array measurement and calibration barge, built in 1970-71 and moored in Portland Harbor off Portland, Dorset. Organizationally CRYSTAL is located in the Sonar Department of A.R.E. Portland under the cognizance of the A.R.E. Transducer Group which is at "A.R.E. North."

The dimensions of CRYSTAL are:

Length	125 m. (413 ft.)
Beam	17 m. (56 ft.)
Draft	1.8 m. (6 ft.)
Displacement	3400 T. (3808 US tons)

In Figure 1-6 (below), the stern section which houses the Heavy Station can be seen rising 93 ft./28.3 m. above the water surface. The Dome Test Station, located in the bow area, is open to the weather. The prominent structure on the bow provides support for the shaft.

There are 8 shafts along the port side and 9 along the starboard side, each capable of supporting and rotating a 2.2-US ton/2-British ton load to depths of 25 ft./7.6 m. One shaft on each side (P5 and S9) is a concentric shaft with inner and outer shafts each capable of handling 2.2 US tons/2 British tons. The shaft locations and separations between shafts are given in Figure 1-5.

All shafting is capable of being lowered to a 25 ft./7.6 m. depth which is the usual working depth for both transmitters and receivers.

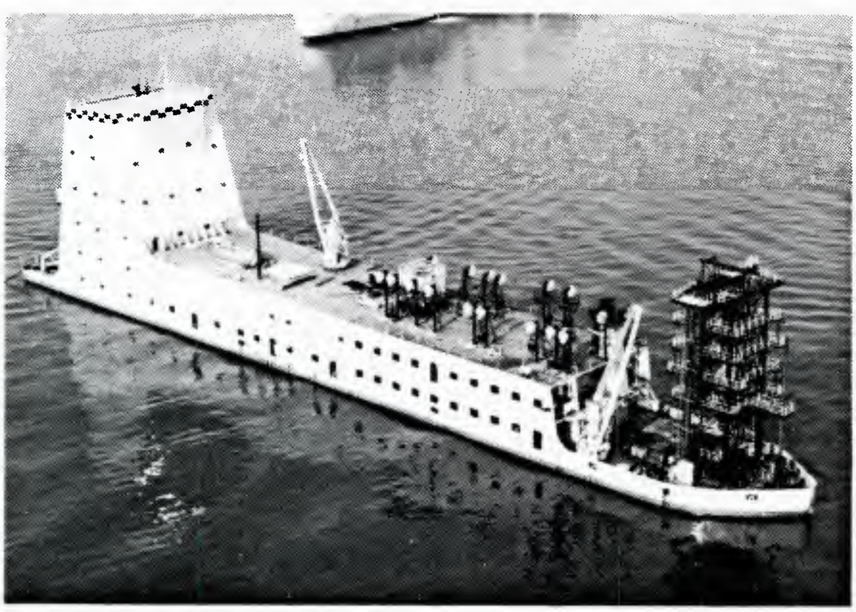


Figure 1-6. R.D.V. CRYSTAL

Additional Comments: CRYSTAL is secured with an extremely heavy four-point moor, stern on to the prevailing wind. There is essentially no yaw and roll is generally less than 1°. Maximum roll is 3°.

Due primarily to depth limitations, acoustic measurements on CRYSTAL are normally restricted to a frequency range of 1 kHz to 500 kHz but occasionally, on demand, measurements are made at frequencies as low as 100 Hz but results are not felt to be reliable.

There are two large handling stations; the open station in the bow termed the Dome Test Station (DTS) and the enclosed stern station called the Heavy Station (HS).

The Dome Test Station is arranged for the testing of large dome and array combinations. A significant feature is the capability for independent rotation of a sonar dome with respect to an array within it. The DTS is provided with a 11-US ton/10-British ton crane and a large open platform trolley for handling such large dome/array combinations. The outer DTS shaft is capable of supporting 11 US tons/10 British tons and the inner shaft can handle 28 US tons/25 British tons. The forward 1.1-US ton/1-British ton (currently non-rotatable) probe shaft (FP) normally used for receiving signals for the Dome/Array under test is 21.5 ft./6.6 m. forward of the DTS shaft and is capable of traverse from surface to bottom. (This is a useful feature for measurement of vertical beam patterns and for measurement of dome loss variation with vertical angle.)

The Heavy Station is located in the enclosure on the stern of the barge. Loads up to 15.7 US tons/14 British tons can be handled on the aft crane, and are lowered to a 40 ft. x 50 ft. (12.2 m. x 15.2 m.) handling trolley through a 16 ft. x 16 ft. (4.9 m. x 4.9 m.) access hatch. The Heavy Station concentric shaft is capable of supporting 112 US tons/100 British tons on the inner shaft and 34 US tons/30 British tons on the outer shaft. The shaft is located in the center of the well and extends to a water depth of 25 ft./7.6 m. (essentially midway between surface and bottom). The well itself is in the shape of a symmetrical cross. The longitudinal section is approximately 60 ft./18.3 m. long and the central athwartship section extends approximately 40 ft./12.2 m. across the barge. Each section is 25 ft./7.6 m. wide.

A near-field scanning system is available for use in conjunction with the HDS where small probe hydrophones are moved parallel to the surface of the array under test, at distances of a few centimeters.

Shore power available on CRYSTAL is 3.3 kV 3 Ø up to 0.5 MW.

On-board main power is

415 V	50 Hz	
440 V	60 Hz	

Power available in the laboratory spaces is

240 V	50 Hz	1 Ø
115 V	400 Hz	3 Ø
115 V	60 Hz	3 Ø
220 V DC		
50 V DC		
24 V DC		

Additional Comments (Cont'd):

In addition, CRYSTAL is equipped with a 300 kVA Diesel generator and two 75 kVA Diesel generators.

In addition to the normal test equipment in the large and roomy laboratory spaces, there are six 800-watt Analog Associates power amplifiers available. (There are an additional 15 such amplifiers in the laboratory ashore should others be necessary.)

For higher power work, customers provide their own amplifiers. Dummy loads are available as well as chilled water supplies for dummy loads and power amplifiers.

The computerized measurement system which will replace the older S.A. systems is shown in Figures 1-1 (block diagram) and 1-2 (rack layout) in the description of the A.R.E. Transducer Development Laboratory.

An overhead monorail with 1.1-US ton/1-British ton hoists runs through all work areas--through inside laboratory spaces and outside to all shaft stations.

The reference elements (the "standards") at A.R.E. are the sources rather than the receivers.

The different reference elements routinely used are:

100 Hz - 1 kHz	NRL Orlando J9, J11
1 kHz - 3 kHz	British ARL Hydrosounder
3 kHz - 8 kHz	A.R.E.-built line array of small tonpilz generators
5 kHz - 120 kHz	A.R.E.-built ADP crystal sources
50 kHz - 300,500 kHz	A.R.E.-built $BaTiO_2$ elements

The above elements are periodically rechecked as standard reference sources. The transmitting responses are established routinely through a trimetric reciprocal calibration, and the stability of each is felt to be totally satisfactory.

Other Information Sources: "A.U.W.E. Acoustic Calibration Facilities," A.U.W.E. Publication 42355, Sept. 1976, by R.J. Gale.

Date of this Summary
10 April 1985

Facility Name: A.R.E. Surface Ship Noise Range

Location: The range proper is one mile/1.6 km. off the east side of the Isle of Portland, visible from the A.R.E. (North) shore facility building which houses the range data-recording equipment (see Figure 1-7).

Cognizant Organization: Admiralty Research Establishment

Facility Functional Name: Portland Noise Range

Major User(s): Royal Navy and allied navy surface vessels

Technical Areas Supported: Surface ship noise reduction

Unique Features: The outputs of six omnidirectional hydrophones are used for establishing ship's signature. One directional hydrophone is used for localization of offending "hot spots" within the vessel. All data are digitized online and stored.

Significant Equipment Available: A permanently mounted theodolite which is hard-wired to a computer (in the same laboratory space) for tracking and for online data recording/analysis; one set of General Radio one-third octave filters; Nicolet Scientific Corp. narrow band analyzer; PDP 1160 with two disc drives; SE 7000 FM 14-track back-up magnetic tape recorder.

Local Environment: Open water, 1 mile/1.6 km. offshore, 70 ft./21.3 m. water depth.

Future Plans for Facility: Continued use anticipated with no significant modifications planned.

Facility Mailing Address: Admiralty Research Establishment
Range Manager
Portland, Dorset DT5 2JS
U.K.

Local Contacts: Head, A.R.E. Sonar Dept.
A.R.E. (North), Portland, Dorset
Tel: 0305-820311

Contact for Access/Scheduling: Requests for use of the range should be made by letter or by naval message to the Range Manager. Access will depend only on presence of other ships previously scheduled. At least one day's notice is desired, when possible.

Narrative Description: Organizationally, the A.R.E. Surface Ship Noise Range is located in the Sonar Department of A.R.E. Portland and is operated under the cognizance of the A.R.E. Transducer Group. Historically, the Range has been in use approximately 100 days out of the year.

Narrative Description (Cont'd):

As noted previously, arrangements for use are to be made with the Range Manager, either by letter or by naval message. The staff is always available, but at least one day's notice is desirable, where possible.

It is considered to be extremely advantageous to all concerned if one of the ship's officers can be present in the Range Laboratory during the trial.

It is considered necessary that stabilizers be locked in position at 00°. (If locked in any other position, cavitation will occur above 15 kt.)

The Range is located in 70 ft./21.3 m. of water 1 mi./1.6 km. offshore (see Figure 1-7). The range is 400 yd./365.7 m. long and straight course can be run at any speed desired. It is marked by four buoys: one pair at each end of the range approximately 100 yd./91.4 m. apart. The pair of buoys on a given side are 400 yd./365.7 m. apart. The ship should run the Range in the central channel; that is, within ±10 yd./9.1 m. of the center.

Additional Comments: The Range sensors consist primarily of six omnidirectional hydrophones mounted on tripods such that the hydrophones are 4 ft./1.2 m. off the bottom. The hydrophones are 1-inch/2.5-cm. Graseby spherical ceramic (PZT) elements. In running the Range the ship will pass directly over some of the omnidirectional hydrophones and will pass 100 yd./91.4 m. abeam of the others.

In addition, there is a single directional element, mounted on a tower, 30 ft./9.1 m. off the bottom. This element, with a beamwidth of 2° at 40 kHz, is used for localizing specific acoustic sources within the ship's overall profile. In running the Range, the ship will pass 50 yd./45.5 m. abeam of this mid-depth receiver.

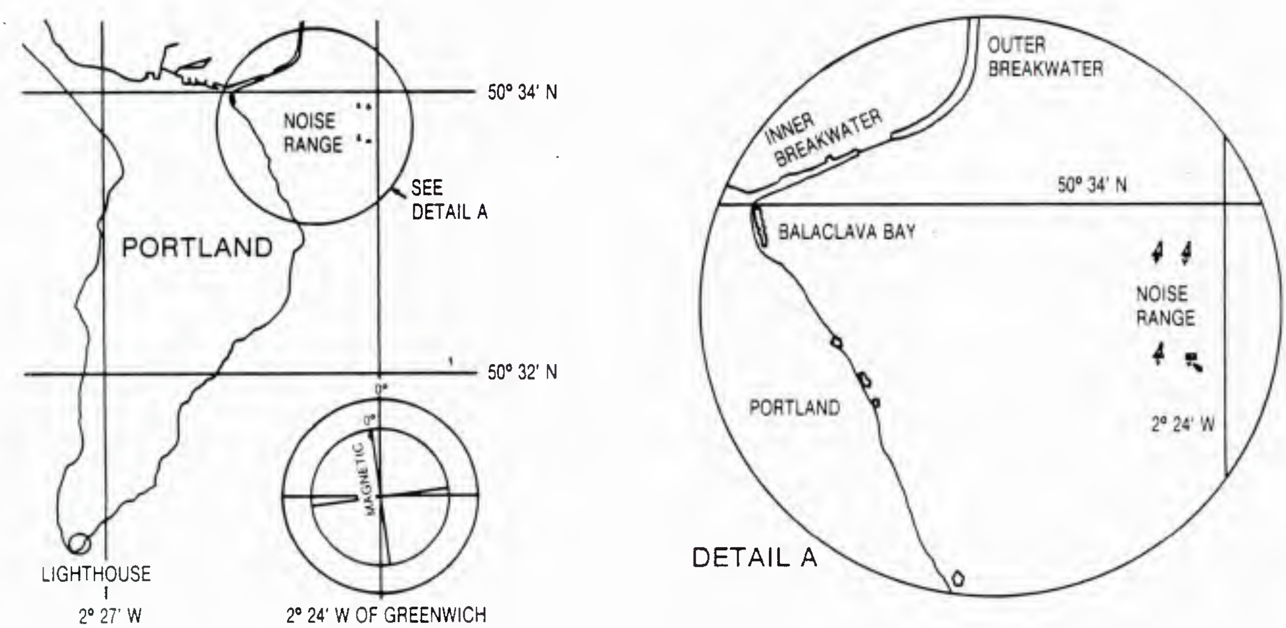


Figure 1-7. Location of A.R.E. Surface Ship Noise Range

Additional Comments (Cont'd):

Ship's position through the 400-yd./365.7-m. long range is closely monitored by a theodolite (permanently mounted in the Range Data Processing Laboratory with a clear view of the Range) which is hard-wired to a DEC PDP 1160 digital computer in parallel with the acoustic inputs.

As a matter of routine, data analysis is performed online and the results in hard copy are available on demand at the conclusion of the trial.

Broadband on-line processing is accomplished with the use of a set of General Radio one-third octave filters extending from 4 Hz to 100 kHz. Narrow band on-line processing is accomplished with a Nicolet Scientific Corp. (now Wave Tek) Ubiquitous Spectrum Analyzer (UA 500 A) covering frequencies up to 2 kHz.

On demand, hard copy is generated on the DEC PDP 1160. This computer is provided with two disc drives allowing 14 megabyte storage on each disc.

Back-up magnetic tape recording is provided by an SE 7000 FM 14 track recorder. This recorder has a standard IRIG format and is normally operated at 120 ips/ 304.8 cm/sec.

For purposes of monitoring and event logging, a six-channel Gould paper recorder is operated.

Other Information Sources: A descriptive report is in preparation as of 10 April 1985. Contact R.J. Gale, Head, A.R.E. Transducer Group.

Date of this Summary
24 May 1985

Facility Name: Acoustic and Acoustic-Related Facilities of A.R.E. Teddington Signature Reduction Dept. See Figure 1-8 (organization chart) on following page.

Location: Teddington, Middlesex, U.K.

Cognizant Organization: Ministry of Defense, Royal Navy

Facility Functional Name: Hydro-Acoustics and Noise Facilities

Major User(s): Royal Navy, Royal Navy contractors and universities

Technical Areas Supported: Noise reduction, flow noise studies, fluid mechanics

Unique Features: Rotating Beam Channel. This system consists of an annular tank of water below the end of a 55.8 ft./17 m. radius rotating beam. Instrumental objects can be suspended below the end of the beam, and moved through the water at speeds up to 97 kt./50 m/s.

Significant Equipment Available: Rotating beam channel, quiet wind tunnel, 30 in./76.2 cm. diameter water tunnel, and an 11 x 20 x 11 ft. deep (3.3 x 6.1 x 3.3 m. deep) transducer calibration tank

Local Environment: Very quiet, suburban.

Future Plans for Facility: To add helium bubble flow visualization to the quiet wind tunnel.

Facility Mailing Address: Superintendent
Admiralty Research Establishment
Queens Road, Teddington, Middx TW11 OLN
U.K.

Local Contacts: Dr. A.N. Hicks, UHA, Hydro-Acoustics and Noise
D.C. Fraser, UJA, Acoustic Ranging and Analysis
Tel: 01-977-3231

Contact for Access/Scheduling:
Mr. J.E. Conolly
Superintendent
Admiralty Research Establishment
Queens Road, Teddington, Middx TW11 OLN
Tel: 01-977-3231 (Ext. 232)

Narrative Description: The rotating beam with its annular water channel (Figure 1-9) is used principally for studies of the stability and control characteristics of weapons (generally torpedoes) and other hull shapes in some propulsion tests. The facility is not normally used for acoustic work in part because it is felt that the concrete walls of the circular trough would make it too noisy. It does appear that it might be useful for some acoustic work,

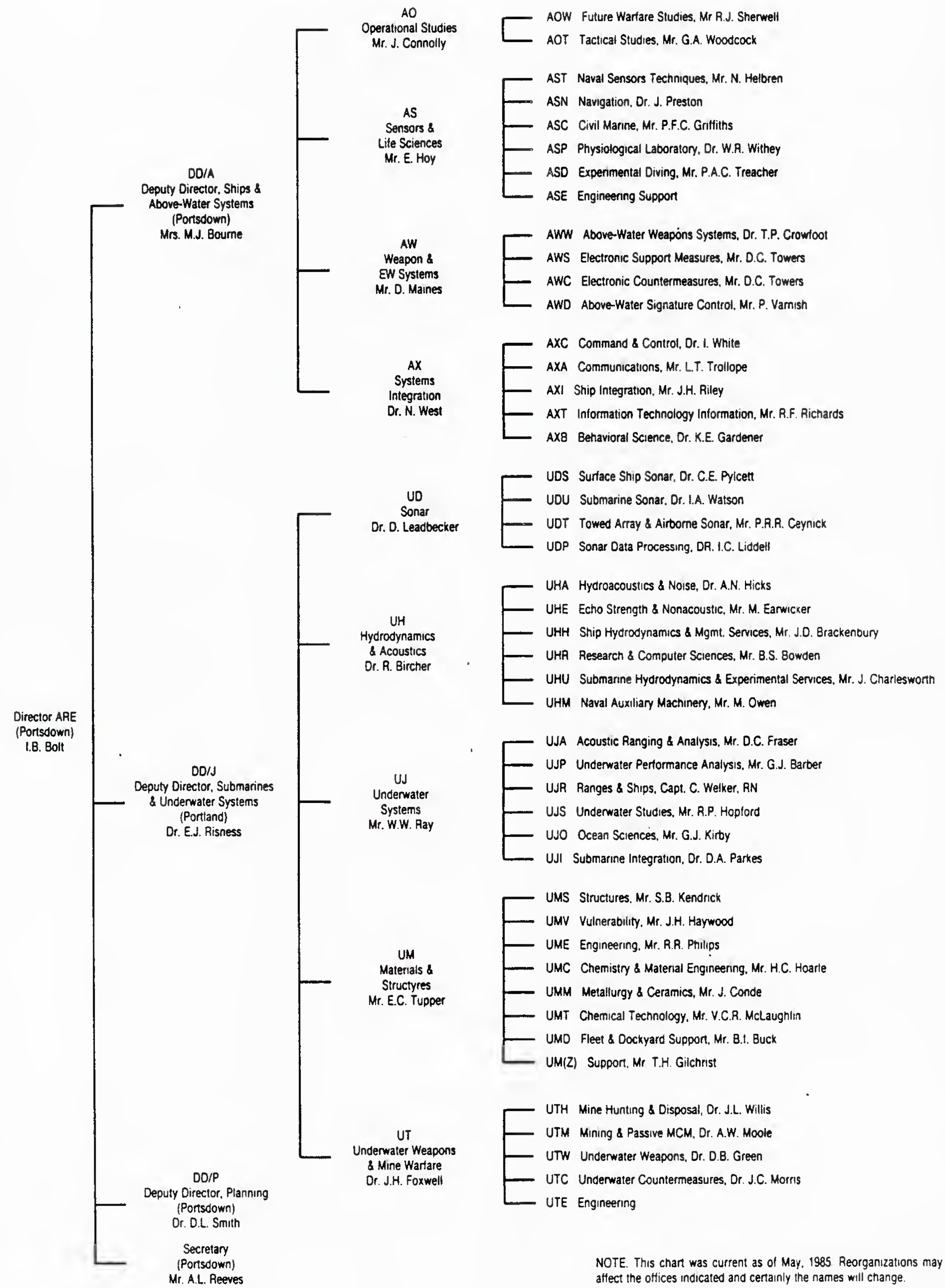


Figure 1-8. Admiralty Research Establishment (Teddington) Organization Chart

Narrative Description (Cont'd):

however, and certainly the speeds achievable and the number of data channels available are attractive features.

The annular water tank has a depth of 16.4 ft./5 m., a 34.4 ft./10.5 m. wide channel with a model path radius of between 49 and 55.8 ft./15 and 17 m. The rotating arm radius is 55.8 ft./17 m. and it can carry up to 100 channels of sensor information back to the hub where the signals are transferred to fixed laboratory cabling by way of mercury troughs. The total length of the rotating beam is 111 ft./34 m. and it is driven by a 800 kW DC electric motor.

Observation windows are provided (see Figure 1-10) and the water can be filtered to a high degree of clarity. High speed photography can be synchronized with the rotation of the model.

Existing instrumentation consists principally of a 6 degree of freedom balance mounted within the model and pressure transducers. As indicated earlier, up to 100 channels of information can be taken from the rotating beam.

The tank is fitted with baffles to limit the build-up of water circulation within the channel and with "beaches" to limit the surface wash from the model support strut.

Test model size and weight is limited to 13.1 ft./4 m. length and 1.5 US tons/ 1.4 British tons.

A description of this facility has been published in the Proceedings of the Institution of Mechanical Engineers, 1957, Volume 171, No. 4.

The A.R.E. Quiet Wind Tunnel site is illustrated in Figure 1-11. It is used primarily in noise reduction studies of sounds originating in and radiating from submarines. It was felt that many of the noise producing mechanisms could be more easily studied in a wind tunnel than in hydroacoustic facilities. Consequently a low noise wind tunnel was designed similar to the BBN installation in the U.S., and construction was completed in 1983.

The wind tunnel is of the open jet, open circuit type. Air is drawn through a 16:1 area ratio reduction, the working chamber, plenum chamber and the fan, as shown in Figure 1-12. The internal dimensions of the working chamber are 13.1 x 13.1 x 9.8 ft. high (4 x 4 x 3 m. high) but the addition of foam wedges for the anechoic treatment reduces the available volume to 9.8 x 9.8 x 6.6 ft. (3 x 3 x 2 m.).

A thick aluminum plate is fixed above the floor 4 ft./1.2 m. below the air jet axis to provide a rigid horizontal datum for the positioning of models and measurement apparatus.

The air is drawn into the working chamber through glass fibre ducting of 18 in./45.7 cm. diameter at speeds up to 97 kt./50 m/s. Models are mounted on the datum plate with much of their length within the ducting so that the tail is within the potential core of the jet where the velocity profile across the duct is flat and the turbulence level is low.

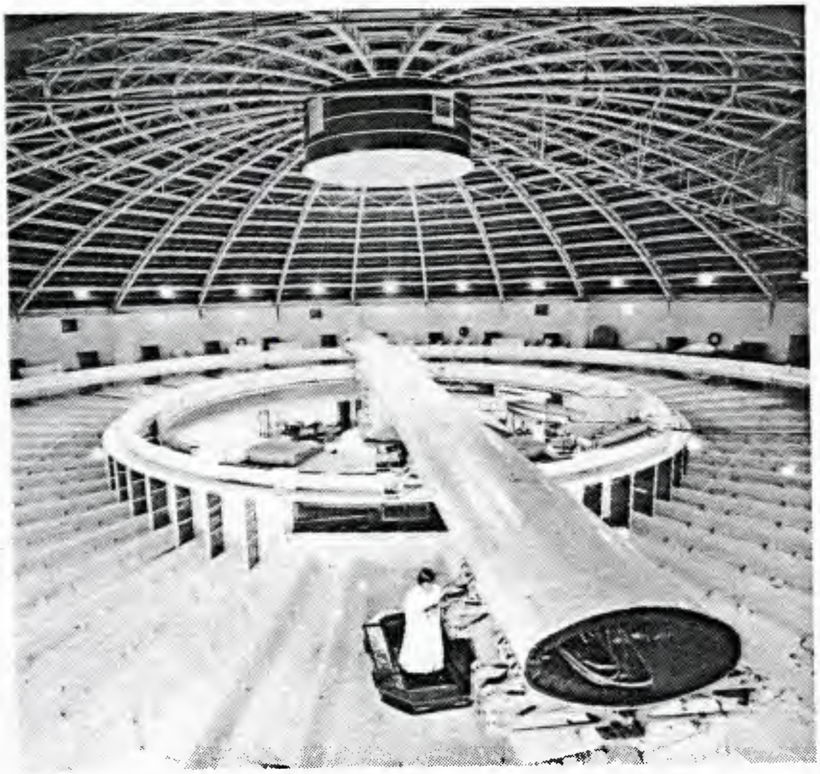


Figure 1-9. Rotating Beam Channel

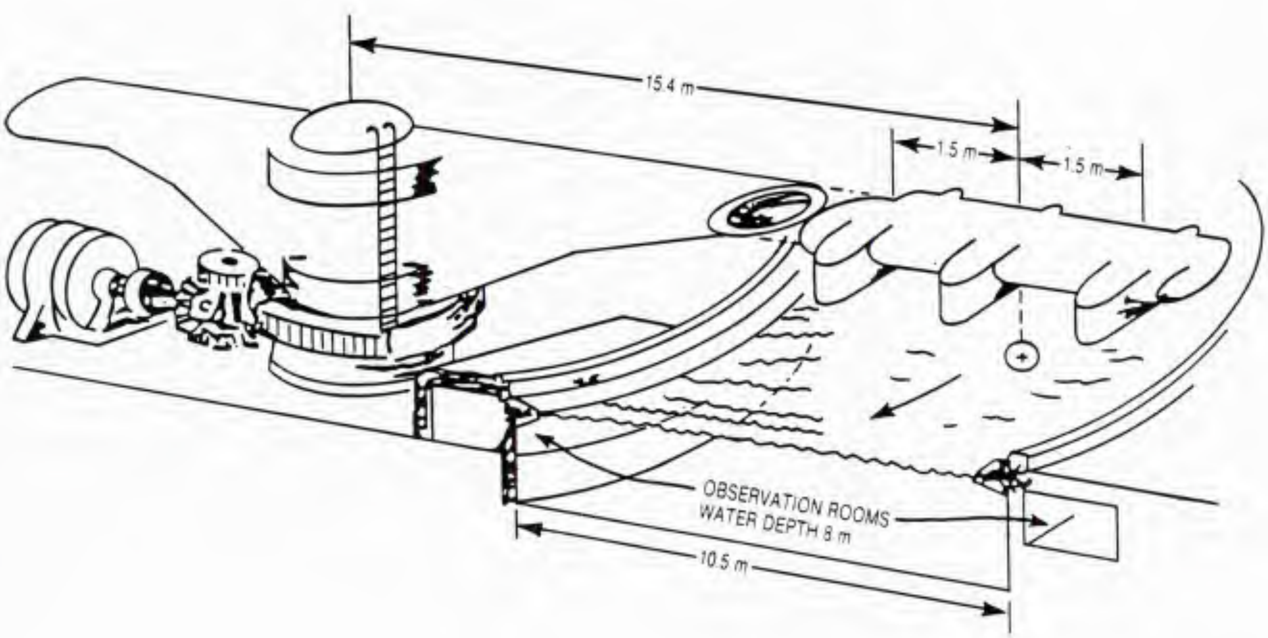


Figure 1-10. Rotating Beam Cutaway Diagram

Figure 1-11. Quiet Wind Tunnel

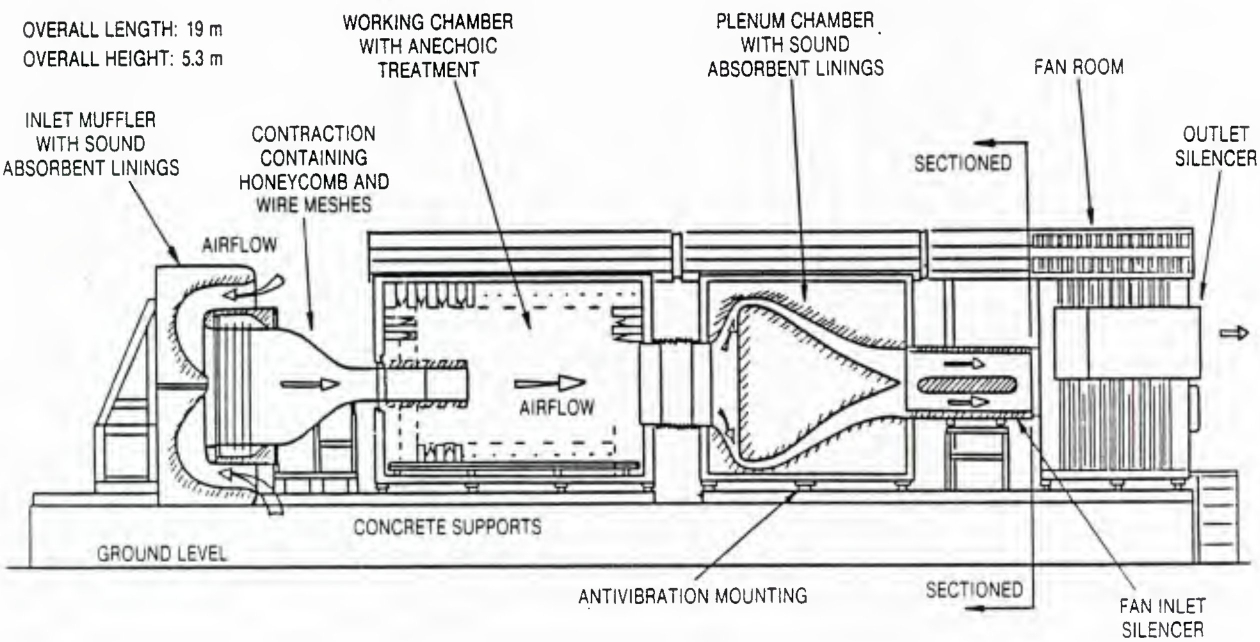


Figure 1-12. Diagram of the Quiet Wind Tunnel

Narrative Description (Cont'd):

The air leaves the working chamber through an outlet hole 4 ft./1.2 m. in diameter. A flexible bellows provides vibration isolation between the working chamber and the plenum chamber, in which the air strikes a perforated stagnation plate and is ducted at low speed through an annulus with sound absorbent treatment both inside and outside. All of this assures high attenuation of noise passing upstream from the fan. (There are no fan tones present in the working chamber under any conditions.) After the plenum chamber, the air passes through an annular silencer and into the fan inlet. The fan is a 12-bladed centrifugal fan driven by a 37 kW DC motor.

The wind tunnel is controlled from a cabin positioned alongside the working chamber and which contains the fan operating controls as well as the noise and flow measuring equipment.

Measurements of the decay of sound pressure level as a function of distance indicate that the working chamber can be considered to be anechoic at all frequencies above 400 Hz.

The overall sound pressure level produced by the wind tunnel when running at 97 kt. (50 m/s.) without a model present is only 70 dB//20 μPa and most of that is at frequencies below 1000 Hz.

A microphone on a rotatable boom is available in the working chamber. Pitot-static and hot-wire anemometer systems are also available for the measurement of mean flow velocity and turbulence and a flow visualization system using neutrally buoyant bubbles has been obtained for investigating turbulent flows. Noise measurements are made with condenser microphones and their associated signal conditioning equipment and when mounted on the rotating microphone boom are used for measuring the directional characteristics of noise sources. A desk-top computer controls data acquisition through a data logger, a digital oscilloscope and a spectrum analyzer and then processes the data.

Reference: "The A.R.E. Quiet Wind Tunnel," Journal of Naval Science, Volume 10, No. 4, Nov. 1984.

The A.R.E. Large Water Tunnel (Figure 1-13) is a recirculating system driven by a 630 kW Ward Leonard motor with pressure variable from 2 to 45 psi/0.14 to 3.1 bars. The working section is 29.9 in./76 cm. in diameter and 18 ft./5.5 m. long and can accept models with diameters up to a maximum of 10 in./25.4 cm. and propellers up to 11.8 in./30 cm. The maximum water velocity in the working section is 59 ft/s. (18 m/s.)

The water tunnel was built in 1954 and is used primarily for cavitation studies on weapon propulsors and for drag and other propulsion measurements. The tunnel is provided with facilities for de-aerating the water as well as for filtering and cooling. It is also constructed so that the return loop is well below the working section to aid in gas resorption during cavitation testing. The resorbing loop is 4 ft./1.2 m. in diameter and is 60 ft./18 m. in height.

A significant feature of the tunnel is the slotted wall in the (relatively) long working section of the tunnel which constitutes a compromise between a short working section and the difficulties of a long solid wall.

Narrative Description (Cont'd):

The tunnel is amply provided with viewing ports and measurement instrumentation which includes pressure transducers, high speed photographic capabilities, a desk-top calculator controlled data logger and internal strain gauges for single and contra-rotating models.

A laser doppler anemometer is available for flow field measurements.

(This larger water tunnel is augmented by an older 12 in./30 cm. tunnel built in 1951 with a 300 hp motor. The smaller unit is now used primarily by contractors and is currently in frequent use for broadband noise measurements.)

Further details of the Large Water Tunnel may be found in the description published in the Proceedings of the Institute of Mechanical Engineers, 1957, Volume 171, No. 4.

The Transducer Calibration Tank (Figure 1-14) at A.R.E. Teddington measures 20 x 11 x 11 ft./6.1 x 3.3 x 3.3 m.). It is fully installed with the top of the tank at floor level and is fully lined with the original rubber Fafnir material for anechoic treatment.

Although the tank is currently used infrequently, the level of instrumentation has been maintained and is more than adequate for the occasional user.

A 1.1-US ton (1-British ton) hoist is available at the tank for handling heavier devices.

Shaft rotation of the single rotatable shaft is accomplished with a Brüel & Kjaer 3922 turntable in conjunction with a decibel turntable control.

The "standard" hydrophone/projectors used are the Brüel & Kjaer series, and except for the 8101 Hydrophone, may be used as either transmitter or receiver.

Additional Comments:

A "quick-look" capability and the option of recording data in an analog fashion is provided by a Brüel & Kjaer 2307 Graphic Level Recorder.

The primary data acquisition system utilizes a Hewlett-Packard Model 85 Desktop Computer which includes a keyboard, video display and thermal printer. A Hewlett-Packard Model 82901M Dual Flexible Disc Drive is provided as an adjunct to this system.

Other instrumentation normally available for use as part of the Calibration Tank Facility includes the following:

Exact	Waveform Generator
Brüel & Kjaer	1405 Noise Generator
Brüel & Kjaer	4440 Gating System
Kemo	Dual Variable Bandpass Filter

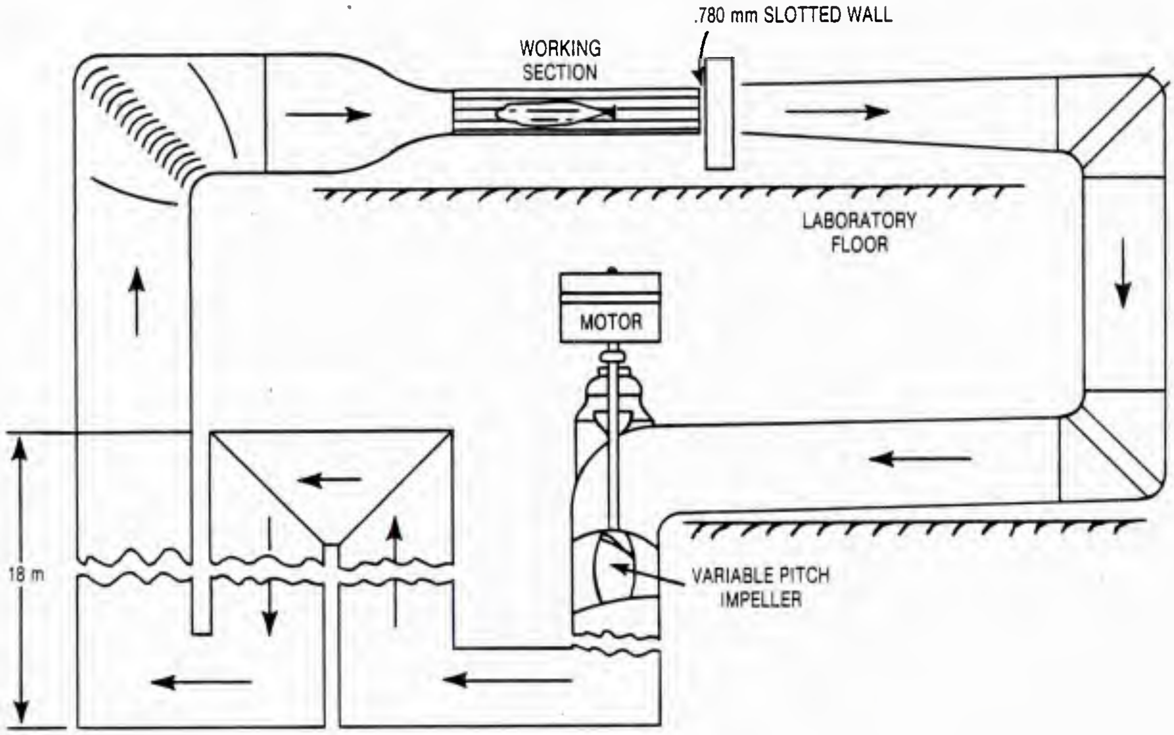


Figure 1-13. Diagram of A.R.E. Large (30-in./76.2-cm.) Water Tunnel

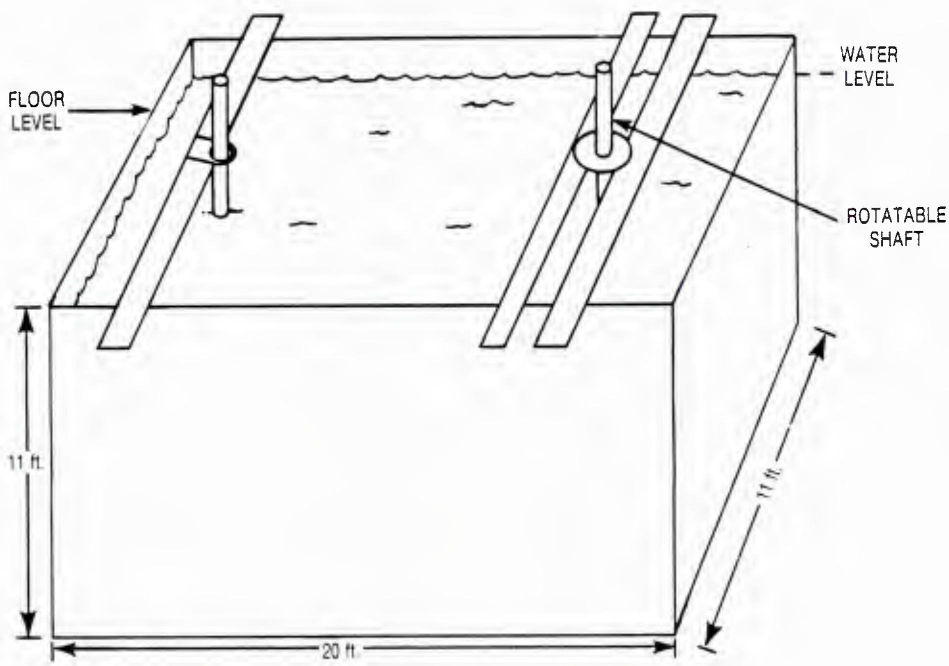


Figure 1-14. A.R.E. Teddington Calibration Tank

Additional Comments (Cont'd):

Bary and Stroud	EF5 110 Bandpass Filter (Low Pass/High Pass)
Brüel & Kjaer	2636 Measurement Amplifier including IEC/IEEE digital interface
Spectral Dynamics	SD345 Spectroscope
Fluke	8520A Digital Voltmeter
A.R.E.	DC Power Supply (for use with Brüel & Kjaer 8101 Hydrophone Preamplifier)
Brüel & Kjaer	2713 Power Amplifier (for reactive high impedance loads)
Derritron	TA300 Power Amplifier (for low impedance loads)

Date of this Summary
28 August 1985

Facility Name: Loch Goil Acoustic Range

Location: Scotland. The station is at the north end of Loch Goil on the west shore opposite the village of Loch Goilhead. The range is 1 mi./1.6 km. south of the station, about 0.5 mi./0.8 km. offshore.

Cognizant Organization: Admiralty Research Establishment, Teddington

Facility Functional Name: Noise Range

Major User(s): Royal Navy; ships and submarines

Technical Areas Supported: Platform noise investigations, quieting

Unique Features: In construction is a capability to provide on-range shore power to a submarine under test.

Significant Equipment Available: Graseby-type range hydrophones with 30 dB preamplifiers; DME tracking system; bow and stern in-water pingers; HP 21 MX computer with terminal, display, disc drive, printer, and plotter; Brüel & Kjaer narrow band analyzer; Spectral Dynamics 4-channel X-Y display; and Brüel & Kjaer 1/3 octave analyzer with display and expansion unit

Local Environment: Very quiet, lake environment. Range is 275 ft./84 m. deep. No freezing.

Future Plans for Facility: To build a new shore building; to add two new barges, a receiving barge and a power barge for submarines; and to obtain new hydrophones. Optical recorders to be replaced by digital recording.

Facility Mailing Address: Admiralty Research Establishment Loch Goil
Mr. J. Revie O/C
Loch Goilhead, Argyll
Scotland, PA 248AA

Local Contacts: Mr. J. Revie O/C -- Address as above
Tel: 030-13-474

Contact for Access/Scheduling:
Mr. D.C. Fraser, N5
Admiralty Research Establishment
Queens Road
Teddington
Middlesex TW 11 OLN

Narrative Description: The Loch Goil Range, located at the north end of Loch Goil in Argyll, Scotland, is in a very quiet area. The range is 275 ft./84 m. deep and is used primarily for submarines and surface vessels for both underway and buoyed static trials.

Narrative Description (Cont'd):

Signals from up to eight hydrophones at a time are brought ashore and recorded across a frequency band from approximately 10 Hz to 40 kHz. The acoustic data acquisition system currently in use is shown in Figure 1-15. (It is expected that the 36 channels of optical recording will be replaced by a Hewlett-Packard digital recording system shortly.)

The hydrophones are Graseby-type units with 30 dB preamplifiers located at the supporting buoys. The preamplifiers are supplied with 24 volts DC from shore and draw 15 milliamperes each.

The hydrophone preamplifier outputs are brought ashore on 4-quad armored cable with "random twist" which terminates at 1:2 isolation transformers in a BNC patch panel. The laboratory area is liberally supplied with additionl BNC patch panels which are in direct communication with the hydrophone panel. (It is also expected that new, as yet unspecified, hydrophones will replace the Graseby-type elements now in use.)

Additional Comments: The range is outfitted primarily for conducting static noise trials of submarines, buoyed at 100 ft./30.5 m. depth, and surface ships. There are also facilities for measuring vessels underway slowly. Instrumentation dedicated to these purposes is shown in the left rack in Figure 1-16. Other analysis, display and recording instrumentation is indicated in the remaining three racks.

Other instrumentation not included in the more permanent rack arrangement shown in Figure 1-16 includes:

Two Brüel & Kjaer 2032 Narrow Band Analyzers (Twin Channel)
One Nicolet Scientific Corp. 444A Mini Ubiquitous (Portable) with Nicolet Model 136A Digital Plotting Adapter
One Barr and Stroud Variable Filter
One Kemo Variable Filter
Four Brüel & Kjaer Level Recorders
One Hewlett-Packard 2645A Terminal (with Display and Keyboard)
One Versatec V-80 (digital) Plotter
A second SE7000 1-inch (2.54 cm.) Tape Recorder -- used only for playback in conjunction with the computer data analysis system.

The range at Loch Goil is a receiving-only range as are the others reported here, and is used largely for submarine radiated noise studies and is primarily a static range.

A new four-quad armored cable (with "random twist") has been installed. This cable is connected to the old hydrophones for interim operations until these hydrophones are replaced with new ones.

Finally, additional short-term plans are three-fold:

1) A new shore building,

2) A receiving barge, to which the new hydrophones will be cabled. (It will be essentially a floating junction box.)

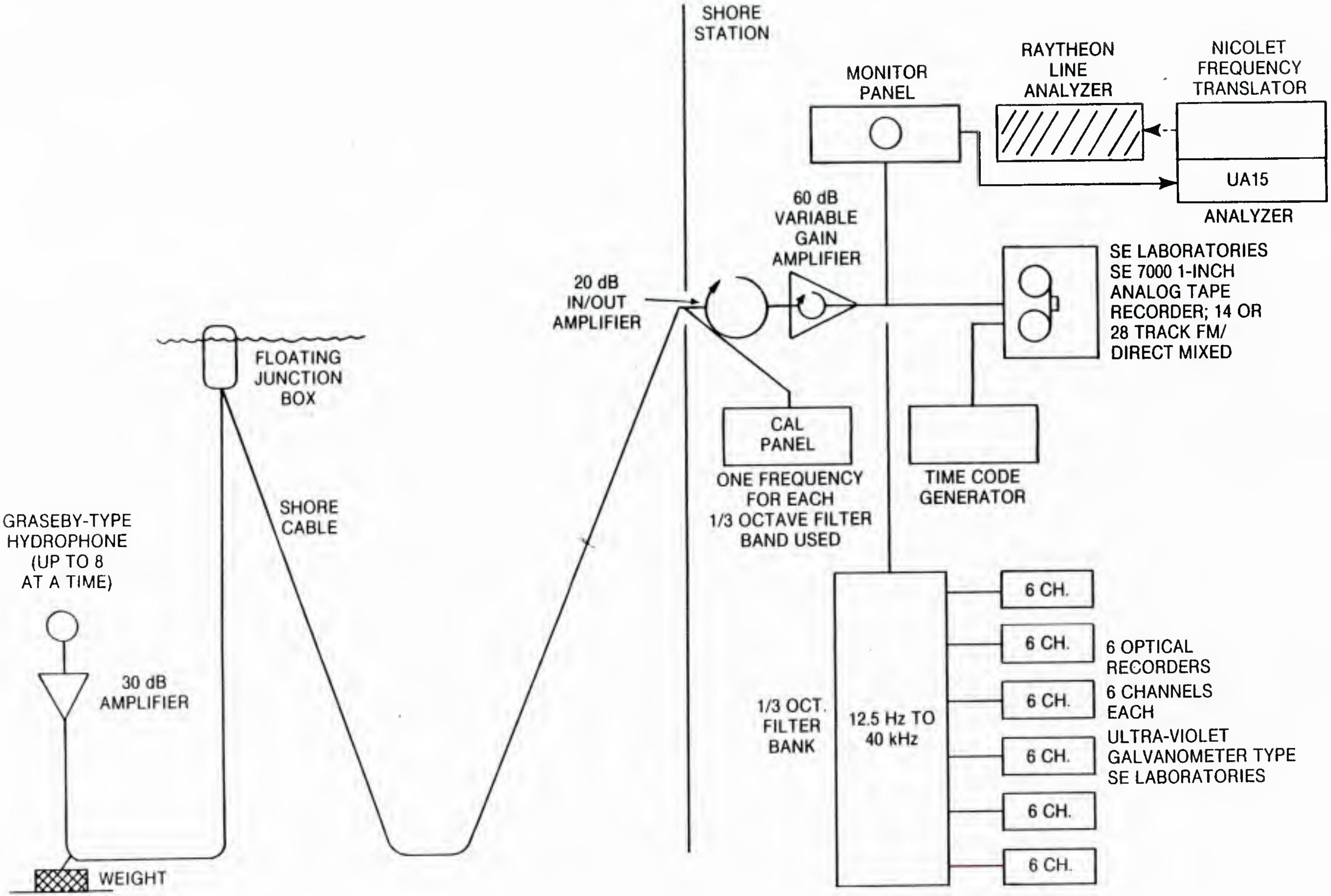


Figure 1-15. Acoustic Data Recording System, Loch Goil Range

Additional Comments (Cont'd):

3) A power barge, to which a special new power cable will be run so that a submarine in a static test configuration can be powered up from shore. This will permit the submarine to operate any of its auxiliaries, one at a time, without running any generators.

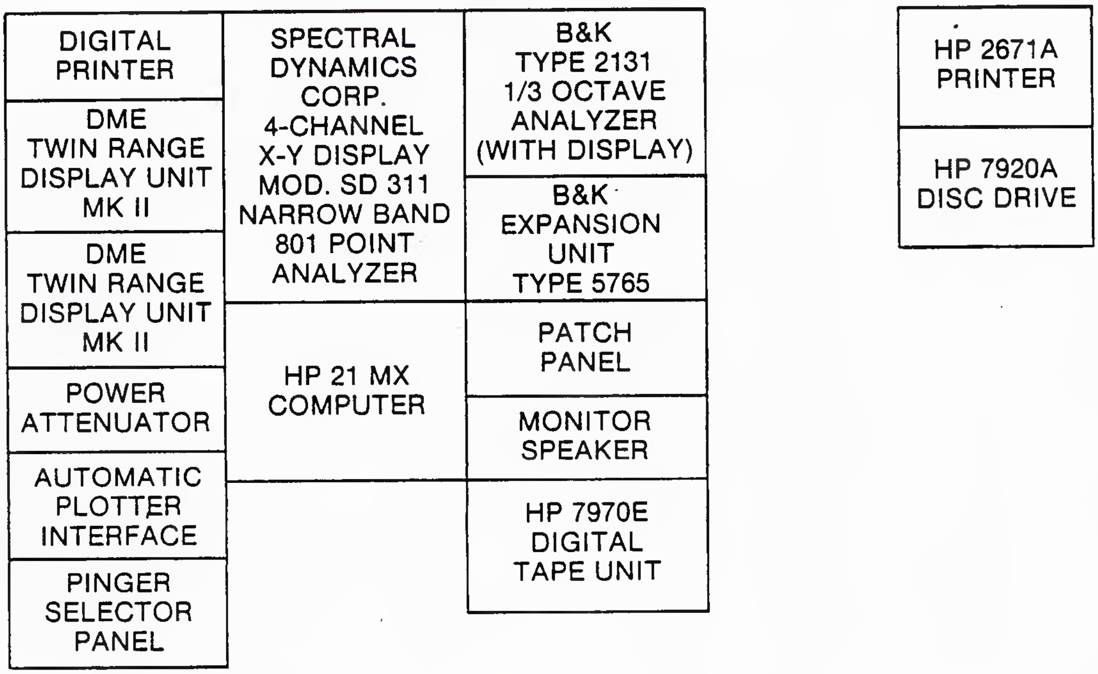


Figure 1-16. Rack Layout, Loch Goil Range

Date of this Summary
28 August 1985

Facility Name: Loch Fyne Acoustic Range

Location: Scotland. The station (and range) is near the northern end of Loch Fyne on the east shore, about a mile north of the town of Strachur and is just off the A815 road.

Cognizant Organization: Admiralty Research Establishment, Teddington

Facility Functional Name: Noise Range

Major User(s): Royal Navy; ships but mostly submarines

Technical Areas Supported: Platform noise investigations, platform quieting

Unique Features: Deeper water than the Loch Goil Range

Significant Equipment Available: Spherical 1-inch (2.54 cm) Graseby-type range hydrophones with integral 30 dB preamplifier; underwater telephone; battery operated hardwired intercom for submarine static tests; line frequency analyzers; ubiquitous spectrum analyzer; 36-channel optical recording 1/3 octave analyzer

Local Environment: Electrically quiet, acoustically quiet except for traffic on A815 road, about 1/4 mile (0.4 km.) from hydrophones. No freezing. Range is 450 ft./137 m. deep.

Future Plans for Facility: None specified.

Facility Mailing Address: Admiralty Research Establishment (Loch Goil)
Mr. J. Revie O/C
Loch Goil Head, Argyll
Scotland, PA 248AA

Local Contacts: Mr. J. Revie O/C -- Address as above
Tel: 030-13-474

Contact for Access/Scheduling:
Mr. D.C. Fraser, N5
Admiralty Research Establishment
Queens Road
Teddington
Middlesex TW 11 OLN

Narrative Description: The mooring and marker buoys of the Loch Fyne Acoustic Range are easily seen from the A815 highway road about 1 mile/1.6 km. north of Strachur. The placement of the key elements of the range are indicated in Figure 1-17.

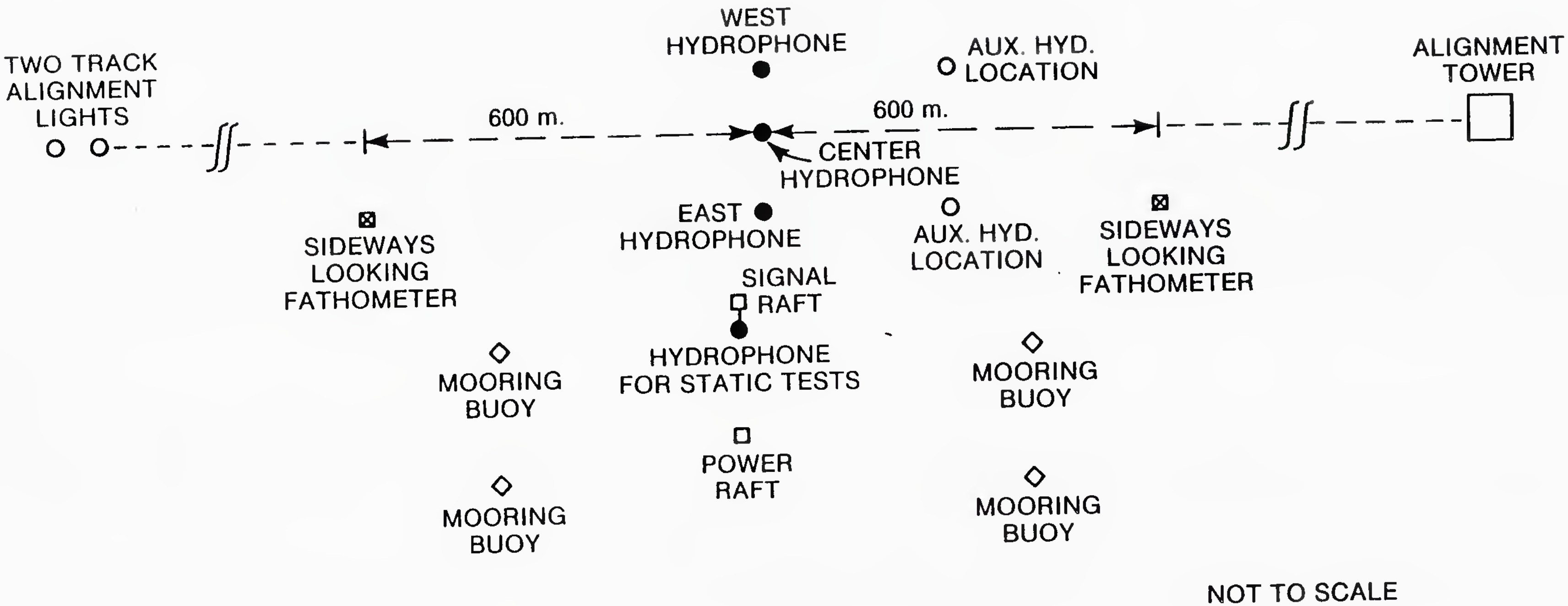


Figure 1-17. Loch Fyne Noise Range

Narrative Description (Cont'd):

This range serves both surface ships and submarines but is used chiefly by submarines. Radiated noise measurements can be made with the vessel in a moored (static) condition or with the vessel underway at slow speeds along the track indicated in Figure 1-17.

The range is 450 ft./137 m. deep. Measurement hydrophones for the underway range are at a fixed depth of 250 ft./76 m. at the points indicated as West, Center, and East hydrophones. Additional hydrophones can also be used at the auxiliary locations shown. Up to eight hydrophones at a time can be used.

The primary hydrophone for static tests is suspended beneath the signal raft at a depth of 100 ft./30 m. where the vessel being investigated would be moored at the four mooring buoys indicated.

At the north end of the Loch is a tower used for alignment along the track, and off to the south of the track are two lights which are used for the same purpose.

Additional Comments: The two sideways looking fathometers have their recorders located in the shore laboratory and are used to monitor and record the east-west deviation of the underway vessel from the track line. The range is also equipped with a DME tracking system.

For underway noise measurements, submarines normally dive to a keel depth of 200 ft./61 m. or less.

For static tests, submarines normally dive to a keel depth of 100 ft./30 m.

Generally static tests of a vessel are made one day and underway measurements of the same vessel are made the following day, but varies subject to requirements.

The hydrophones used are 1-in./2.54-cm. spherical ceramic elements and are packaged integrally with 30 dB-gain preamplifiers. The preamplifiers are supplied with 24 volts DC at 15 milliamperes each from a power supply located in the shore laboratory. The hydrophone cables are brought to the signal raft from where 7 core/7 conductor cables run the 1640 ft./500 m. to termination panels in the shore laboratory.

The laboratory building onshore is a sheet metal (steel) structure, presumably grounded. The laboratory experiences little or no electromagnetic interference and no isolation transformers are required between the hydrophones and the shore measurement equipment.

Figure 1-18 is a sketch of the Loch Fyne hydrophone/recording system.

The in-house analysis and quick-look instrumentation group at the Loch Fyne Range Laboratory is given in the block diagram in Figure 1-19.

Finally, the range/position instrumentation group at Loch Fyne is shown in Figure 1-20.

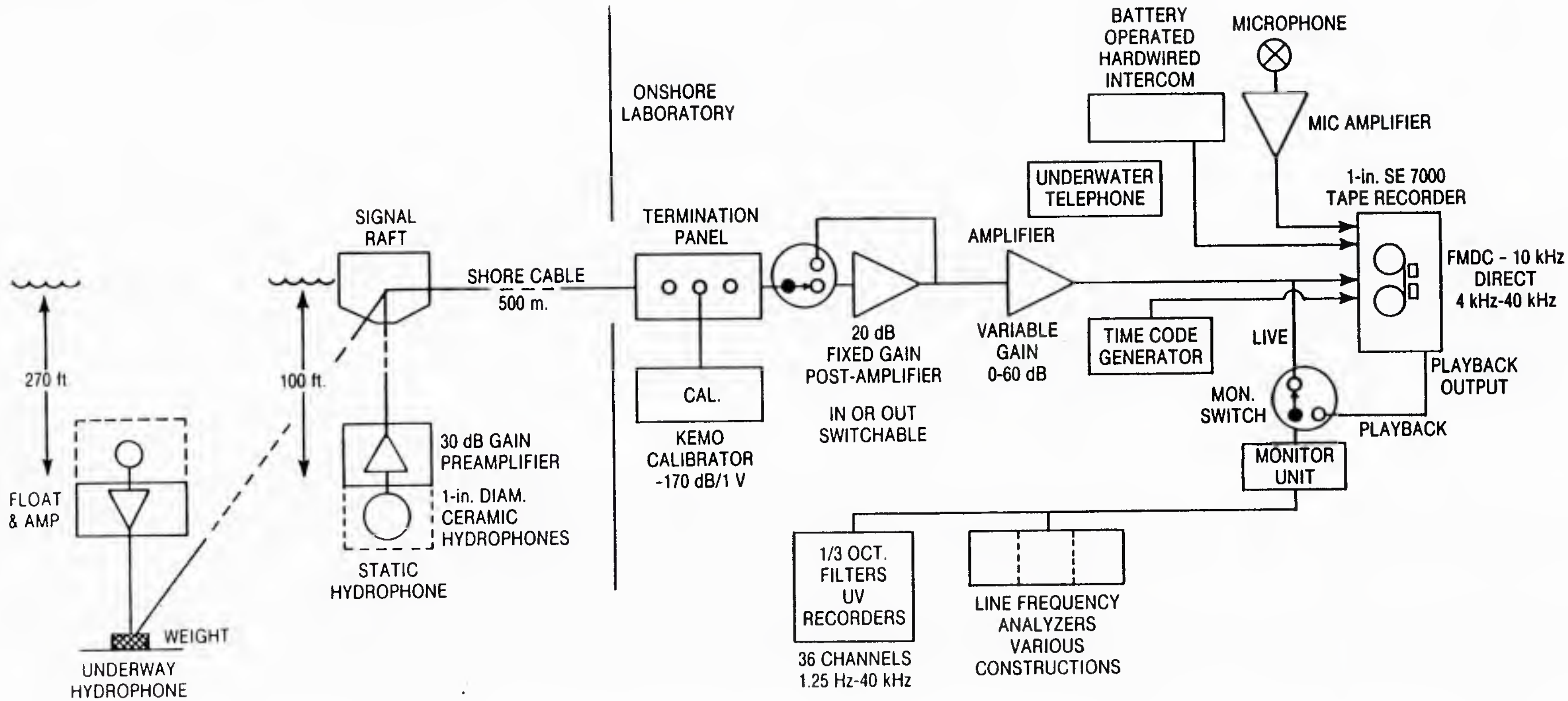


Figure 1-18. Loch Fyne Data Acquisition System

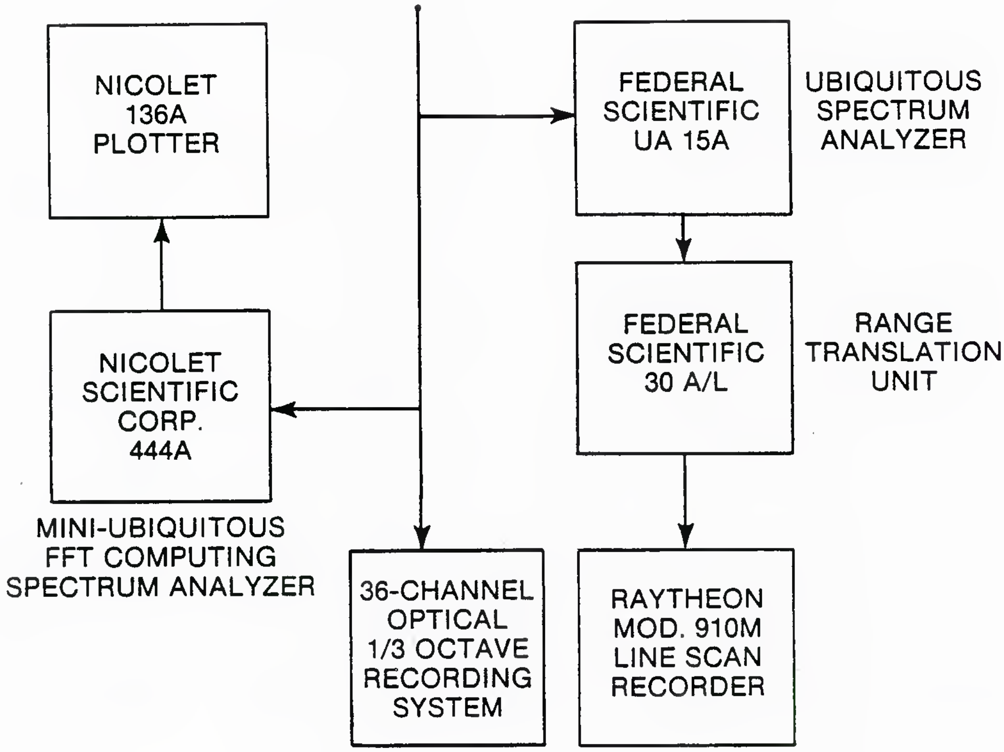


Figure 1-19. Loch Fyne Analysis Instrumentation Group

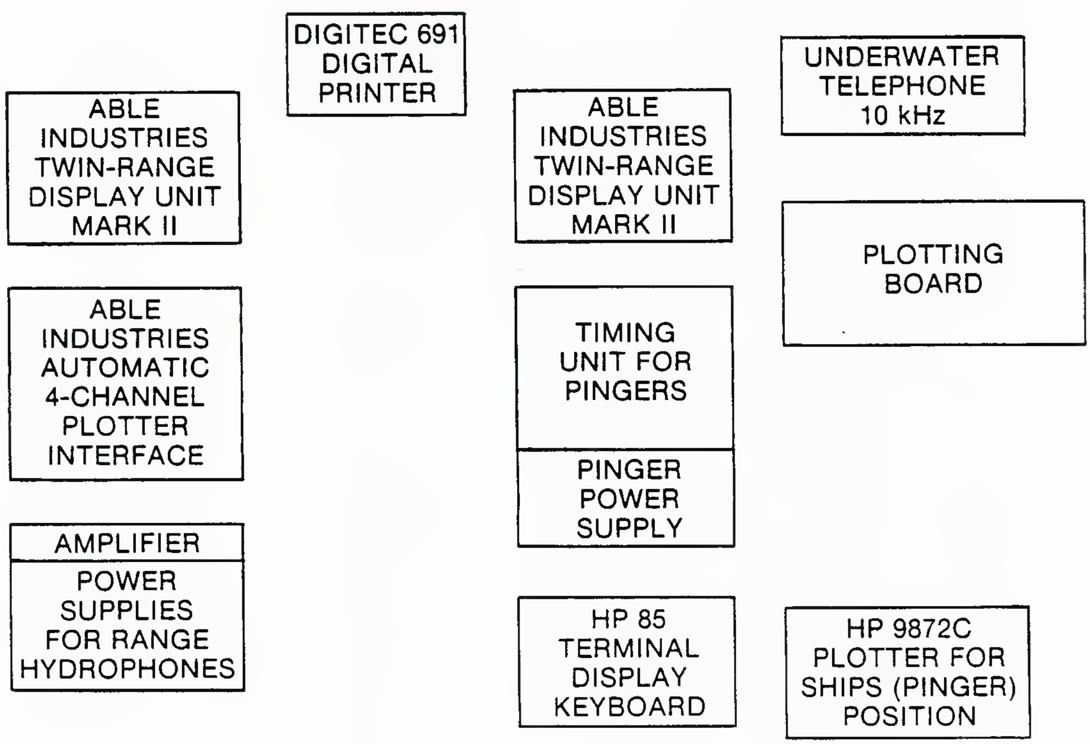


Figure 1-20. Loch Fyne Position Instrumentation Group

Date of this Summary
30 August 1985

Facility Name: Rona Acoustic Range

Location: Scotland; Island of Rona, off Kyle of Lochalsh

Cognizant Organization: Admiralty Research Establishment, Teddington

Facility Functional Name: Ship/Submarine Noise Range

Major User(s): Mainly Royal Navy submarines; some Royal Navy surface ships

Technical Areas Supported: Platform noise studies, platform quieting

Unique Features: Deep range (750 ft./229 m.). Primarily underway range for submarines and large surface ships. Variable depth hydrophones. Tracking hydrophones with sonar beacons and underwater telephones.

Significant Equipment Available: Variable depth hydrophones, from surface to bottom; two SE 9000 tape recorders for continuous recording; tracking radar; underwater tracking range recorders, display; communications from both radio links and underwater telephone; microwave surface tracking

Local Environment: Remote island location. Significant boat/ship daytime traffic in range area. (Night operations are preferred for interference considerations.) Deep water (750 ft./229 m.). Year round operations. Reached by helicopter or supply vessel.

Future Plans for Facility: None specified.

Facility Mailing Address: Send via Mr. D.C. Fraser, N5
Admiralty Research Establishment, Teddington
(See below -- Contact for Access)

Local Contacts: Mr. David McGee
RCA Resident Representative
Tel: 047-062-241

Contact for Access/Scheduling:
Mr. D.C. Fraser, N5
or Mr. Gordon Knight
Admiralty Research Establishment
Queens Road
Teddington
Middlesex TW11 OLN

Narrative Description: The Acoustic Range off the Island of Rona lies in the inner sound in the northwest part of Scotland between Rona and the mainland. (See Figure 1-21.)

The laboratory is reached normally by contract helicopter from the Royal Navy Base in Kyle of Lochalsh or, if necessary, by supply ship from the same point. The helicopter trip takes approximately 15 minutes each way. (The supply ship

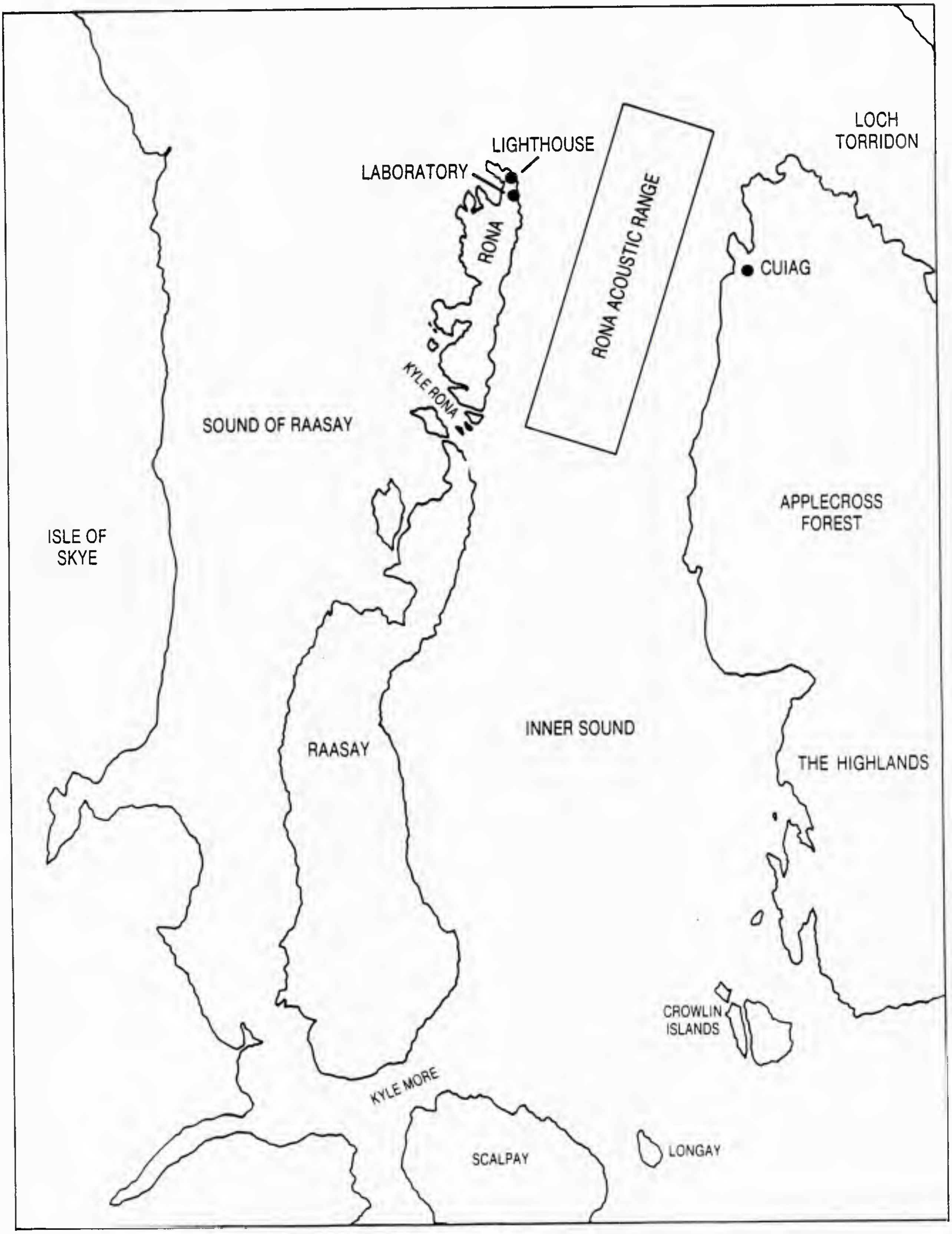


Figure 1-21. Rona Acoustic Range

Narrative Description (Cont'd):

is a three hour trip each way.) The helicopter normally makes two round trips each day leaving the Navy Base at 0815 and 1600, and stops at Applecross on each leg of each trip. The supply vessel routinely brings the heavy or bulky materials to the island including food, fuel, and heavy equipment.

The island laboratory installation is supported by the Royal Navy in Kyle of Lochalsh.

The original installation of the present Rona Laboratory/Range was made for the Admiralty Marine Technology Establishment by Thorn EMI in 1977-78. Since that time, the contractor has changed and operation and maintenance of the range and laboratory is carried out by RCA Service Division under the management and administration of A.R.E. Teddington.

All requests for range time and all schedules pass through Mr. Gordon Knight at A.R.E. Teddington.

The current on-site RCA contractor manager is Mr. David McGee.

Additional Comments: Generally, noise measurements on the Rona Range are made at night due to the fact that interfering ship traffic noise is greatly reduced at that time.

Noise measurements of a single vessel normally require 12 to 48 hours of on-range time. The range is engaged in actual testing approximately 12.5 days per month on average, and there are about 125 "trial-days" per year.

A quite sophisticated data measurement and online analysis system permits a rapid turnaround from Monday measurements to Friday report publishing.

The Rona Range sensor configuration is indicated in Figure 1-22. The open circles (o) indicate relative locations of 9 tracking hydrophones, each with a sonar beacon and underwater telephone.

The solid circles (•) indicate the locations of the noise measurement hydrophones. Four of these hydrophones are variable in depth from surface to bottom with underwater winches. The fifth winch is not functioning and the hydrophone at that location is currently fixed at 600 ft./183 m. Not shown here is an additional hydrophone, at a depth of 400 ft./122 m., located north of the range proper, which is used only for torpedo noise evaluations.

As stated previously, the range is used by both submarines and surface ships, but is primarily used for underway submarine measurements.

The range depth is approximately 750 ft./229 m. and surface ships can transit the range without speed limit.

Submarines normally transit at a depth of 300 ft./91 m. and at a maximum speed of 25 knots. When higher submarine speeds are required, arrangements are made prior to the trial.

Additional Comments (Cont'd):

The tracking hydrophones are Brüel and Kjaer Model 8101 elements. The outputs of these hydrophones are brought into the laboratory to a rather sophisticated Tracking And Positioning System (TAPS) which computes, displays, and records the vessel position (in X, Y, and Z coordinates) throughout the trials. The working velocity used by the Slant Range Processor (SRP) in this system is 4859 ft/s. (1481 m/s.). (This value is refined to reflect local temperature variations as measured at the measurement hydrophone locations if necessary.)

A key element of the tracking system is the pinger attached to the vessel (normally a submarine) being measured. The vessel also carries the master time synchronizing source and the EMI power amplifier to drive the pinger. The pinger transmits signals at one of three different frequencies at an output level of +190 dB//μPa at a 2-second repetition interval. The pinger signals are received at the nine tracking hydrophones indicated in Figure 1-22.

The submarine is provided navigational assistance from the sonar beacons associated with each of the tracking hydrophones and is also in direct communication with the laboratory via the underwater telephones also located at the tracking hydrophones.

Vessels on the surface can be tracked by radar (two antennas are available, one north looking and the other south looking) and/or a MIST (MIcrowave Surface Tracking) system also used for range surveys.

Surface communications include VHF, UHF, and HF circuits, and the underwater telephone system previously mentioned.

The measuring hydrophone system consists of a bottom mounting structure, a variable length of cable, the main support buoy, a fixed 120-ft./37-m. long section of cable and an upper hydrophone buoy supporting the receiving hydrophone at the top. This arrangement is shown in Figure 1-23.

The main buoy contains: a winch and a winch motor, a flooding alarm, a tilt sensor, calibration, a pinger, a depth sensor (pressure), and an acoustic velocimeter (not functioning on all units).

It is possible for those units on which the acoustic velocimeter is functioning to make an entire velocity profile from surface to bottom.

The outputs of the five measurement hydrophones are cabled into the laboratory and subjected to one or more online data analysis procedures and simultaneously recorded digitally and on analog tape.

The analog tape recordings are the ultimate back-up and log for each trial. Analog recording is performed on two Thorn EMI Datatech SE 9000 tape recorders. These recorders are 1-in./2.54-cm., 14 track units. There are seven direct record channels (5 kHz to 100 kHz) alternated with seven FM channels (DC - 10 kHz). There are also three additional tracks: Track 8 -- a digital "trash" track -- records the X-Y coordinates of noise sources; Track 16 -- a communications channel -- for submarine or surface ship; Edge Track -- a voice log.

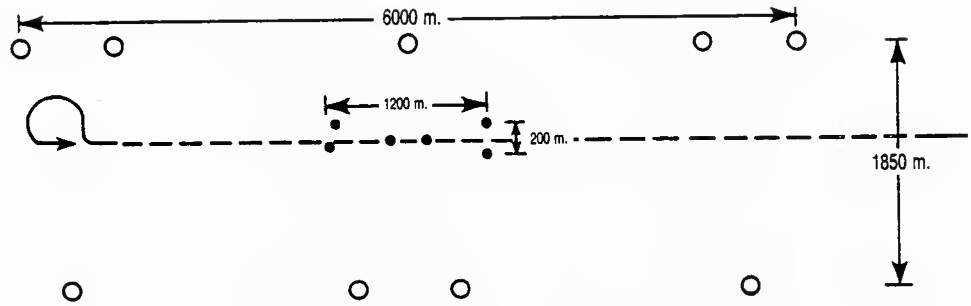


Figure 1-22. Rona Range Sensor Configuration

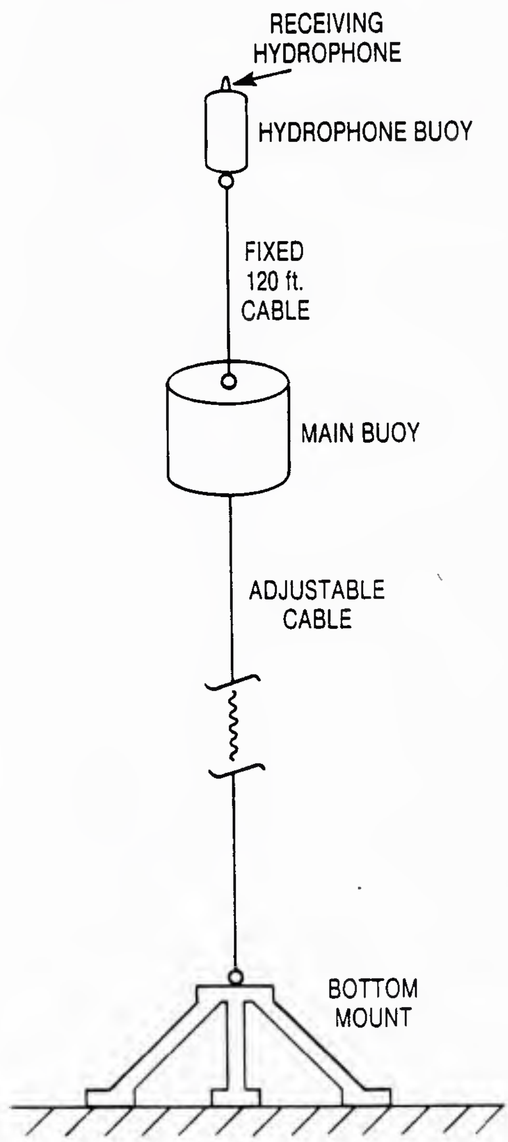


Figure 1-23. Receiving Hydrophone Arrangement

Additional Comments (Cont'd):

The two SE 9000 recorders are alternated in use for continuous recording throughout a trial. A routine trial will accumulate approximately 20 recorded tapes.

The laboratory instrumentation arrangement is indicated in Figure 1-24 and keyed to the rack designation. The instrumentation included in each rack is listed in the following pages.

The upper half of the Power and Weather Monitor Station includes meters to monitor:

Service Load	Instrumentation Load
Service Frequency	Instrumentation Frequency
Service Voltage	Instrumentation Current
	Instrumentation Voltage

The lower portion of the Power and Weather Monitor Station includes:

Wind Direction Gauge	Windspeed Gauge
Wind Direction Recorder	Windspeed Recorder

The instrumentation located in the rack positions indicated in Figure 1-24 is identified below.

A_1	A_2	A_3	A_4	A_5
TV Camera Remote Control MIST (Microwave Surface Tracking)	HP 7210A Digital Plotter	Versatec V-80 (Printer & Plotter)	HP 2640A Terminal (Keyboard & Display)	Tektronix 41014-1 Terminal

A_6	A_7	A_8
Monitor Speaker	HP 9810 Calculator	HP 9862A Calculator Plotter

These two items no longer used.

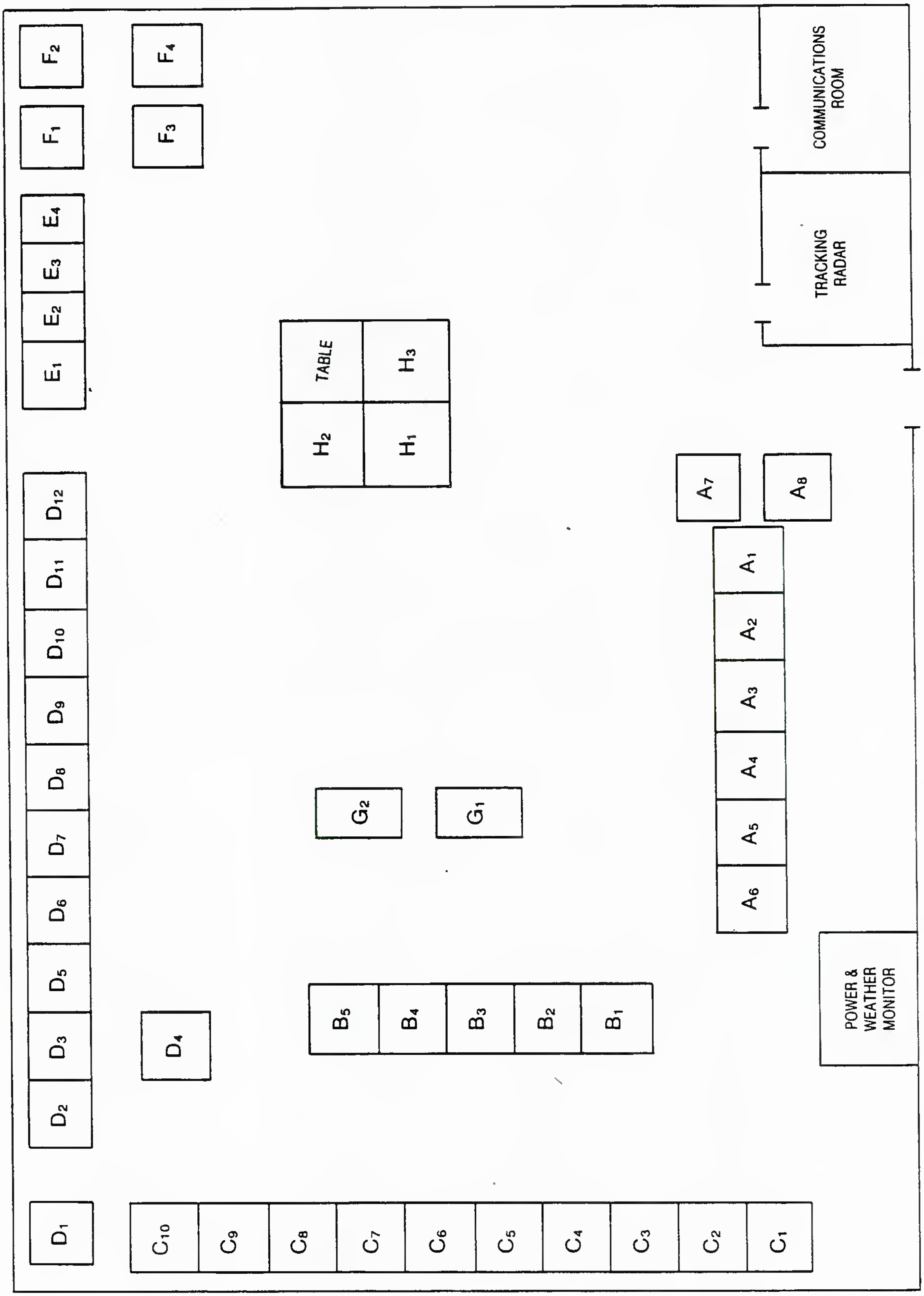


Figure 1-24. Rona Laboratory Arrangement

B_1-B_5 constitute the Trial Operator's Console.

B_1	B_2	B_3	B_4
TRACKING DISPLAY (Digital)	CONTROL	COMMUNICATIONS	MONITOR
Vessel Coordinates Vessel Slant Ranges Water Depth Time of Day Track Error Noise Hydrophone	Noise Hydrophone Tracking Array Selection Source Selection Clock Selection Recorder Controls	Radio Link Exchange Underwater Telephone Control Underwater Telephone Sonar Beacon	Hydrophone Speaker Selection

C_1-C_8 are the locations of the instrumentation for the Tracking and Positioning System (TAPS). C_9-C_{10} are the locations of the analog recorders.

C_1	C_2	C_3	C_4	C_5
HP 2748B Punched Paper Tape Reader	HP 7900A Disc Drive	Slant Range Processor (with Filters)	Slant Range Processor (with Filters)	Clock RDL-EMI
HP 21MX Computer Series	HP 13215A Disc Power Supply	Slant Range Processor (with Filters)	Slant Range Processor (with Filters)	Clock RDL-EMI
HP 7900A Disc Drive	HP 12979A I/O Extender	Slant Range Processor (with Filters)	Slant Range Processor (with Filters)	Velocity Processor
HP 13215A Disc Power Supply	HP 12979A I/O Extender	Slant Range Processor (with Filters)	Slant Range Processor (with Filters)	Source Selector (of Slant Range Processor)
HP 2895B Paper Tape Punch		TAPS Hydrophone Selector (Group 1)	Patch Unit	Noise Hydrophone Patch Panel
		TAPS Hydrophone Selector (Group 2)	Three Buffer Amplifiers with Power Supplies	Depth SRP and Pinger Selector
		TAPS Hydrophone Selector (Group 3)	Three Buffer Amplifiers with Power Supplies	Three Buffer Amplifiers with Power Supplies
			Three Buffer Amplifiers with Power Supplies	Three Buffer Amplifiers with Power Supplies

C_6

Dual Channel Buffer Amplifier

KEMO 1/3 Octave System Calibrator

HP 3330B Automatic Synthesizer

DATRON 1061 (Digital Voltmeter)

Calibration Control (Variable Attenuators on 20 dB Gain)

Four Channel Simulator (Scenario Generator)

Three Buffer Amplifiers with Power Supplies

Three Buffer Amplifiers with Power Supplies

10 Hz High Pass Filters

C_7

RDL-EMI Source Selector

RDL-EMI Transport Control

Tektronix D-40 Monitor Oscilloscope

RDL-EMI Dual Monitor Selector Audio/Visual

RDL-EMI FDH Control Units

RDL-EMI FDH Control Units

RDL-EMI VDH Control

C_8

RDL-EMI De-Multiplexer

RDL-EMI 12-Channel Reconstitution Amplifier*

EMI 14-Channel Auto-Ranging Amplifiers (12 only used)

RDR Voice Log

VDH Control

C_9

Thorn-EMI Datatech SE9000 Analog Tape Recorder

C_{10}

Thorn-EMI Datatech SE9000 Analog Tape Recorder

*The 12-Channel Reconstitution Amplifier is used only for playback of data recorded from the 12 auto-ranging amplifiers

D_1

Versatec V-80 Printer

B&K 5765 Expansion Unit

D_2

HP Color Monitor

HP Color Monitor

D_3

HP 7925 Disc Drive

D_4

HP 7935 Disc Drive

D_5

Federal Scientific UA 500 Ubiquitous Spectrum Analyzer

D_1 (Cont'd)	D_2 (Cont'd)	D_3 (Cont'd)	D_4 (Cont'd)	D_5 (Cont'd)
B&K Type 2131 Digital Frequency Analyzer	HP 7970E Digital Tape Handler			Federal Scientific UA 500 Ubiquitous Spectrum Analyzer
	HP 1000 A900 Digital Processor			Federal Scientific UA 500 Ubiquitous Spectrum Analyzer
				Federal Scientific UA 500 Ubiquitous Spectrum Analyzer
				Federal Scientific 30A Range Translation Unit
				Federal Scientific 30A Range Translation Unit

D_6	D_7	D_8	D_9	D_{10}
B&K 5765 Expansion Unit	B&K 5765 Expansion Unit	Narrow Band Analyzer	Narrow Band Analyzer	Speaker
B&K 2131 Digital Frequency Analyzer	B&K 2131 Digital Frequency Analyzer	Narrow Band Analyzer	Narrow Band Analyzer	Speaker Amplifier
Electronic Visuals EV8000 Display Unit (Dual Channel)	Data V 7-Channel Monitor Oscilloscope	Plasma Data Display Unit	1/3 Octave System I/P Buffers	Tektronix D10 Monitor Oscilloscope
		B&K 1405 Noise Generator	KEMO System 879 1/3 Octave Calibrator	Frequency Synthesizer

D_6 (Cont'd)

Electronic Visuals EV8000 Display Unit (Dual Channel)

Federal Scientific Nicolet, Ltd. Switching Panel

KEMO System 2253 Elliptic Summation Filter

D_7 (Cont'd)

Thorn-EMI Tape Control Unit

NB Controlled Gain Unit (Two Range Displays)

KEMO Type VBF/8 Dual Variable Filter

KEMO Type VBF/8 Dual Variable Filter

KEMO System 2117 Elliptic Summation Filter

HP 1000 A600 Processor

D_8 (Cont'd)

HP 21 MX Processor

HP Graphics Digital Processor

HP 1000 Floating Point Processor

HP 12979B I/O Extender

SE 434

D_9 (Cont'd)

RDL-EMI Calibration Control

Source Selector

Demodulator and Test Unit

Noise Hydrophone Selector

D_{10} (Cont'd)

D_{11}

HP 7970E Digital Tape Unit

HP 7905 Disc Drive

HP 2748B Tape Recorder

D_{12}

HP 7970E Digital Tape Unit

HP 8064A Real Time Audio Spectrum Analyzer

HP 8065A Real Time Analyzer Module LF Extender

310 Real Time Expander HF Extender

E_1	E_2	E_3	E_4
MFE 8-Channel Paper Recorder	2-Channel Heat Stylus Paper Recorder	2-Channel Heat Stylus Paper Recorder	2-Channel Heat Stylus Paper Recorder

F_1	F_2	F_3	F_4
Line Frequency Analyzer	Line Frequency Analyzer	Line Frequency Analyzer	Line Frequency Analyzer

(Note: F_1, F_2, F_3, and F_4 are old units and are being replaced with new Raytheon Analyzers.)

G_1	G_2
HP 2627A Terminal (Keyboard and Color Display)	HP 2648A Graphics Terminal (Keyboard and Display)

H_1	H_2	H_3
Versatec V-80 Plotter/ Printer	HP 2648 Graphics Terminal (Keyboard and Display) HP 2671A Digital Printer	Systematics General Corp. Keyboard and Display

Date of this Summary
14 June 1985

Facility Name: J&S Marine, Ltd.

Location: Barnstaple, North Devon, U.K.

Cognizant Organization: Cray Electronics Group

Facility Functional Name: Transducer/Hydrophone Production Plant

Major User(s): Test/measurement equipment used almost solely by J&S Marine. Major customer is Ministry of Defense (Royal Navy) purchasing sonar elements.

Technical Areas Supported: Transducer/hydrophone development

Special Programs Supported: A large effort in Transducer Refurbishment Program for Royal Navy

Unique Features: J&S Marine is a major supplier of transducers and sonar elements for Royal Navy sonars

Significant Equipment Available: Anechoic measurement tank, with associated hydrophone calibration system; impedance/admittance measurement equipment; electronic fabrication facilities; extensive machine shop facilities; transducer fabrication and assembly facilities; and towed array fabrication facilities

Local Environment: On a quiet road on extreme outskirts of a small town (Barnstaple) bordering rural area. A very attractive site.

Future Plans for Facility: Acquisition of a larger anechoic test tank is planned. A move to new and enlarged towed-array fabrication and assembly facilities is expected during the fall of 1985.

Facility Mailing Address: J&S Marine, Ltd.
Mr. D.R. Cullen, Director
Pottington Industrial Estate
Barnstaple
North Devon EX 31 ILY
U.K.

Local Contacts: Mr. Clement
Chief Project Manager for Transducer Group
Telephone for J&S Marine, all offices:
Int. Oper. + 44 + 271 72141

Contact for Access/Scheduling: For use or scheduling of technical facilities:
Chief Engineer
A. Middleditch
At Above Address

Narrative Description: J&S Marine, Ltd., is a 308-member organization located on the periphery of Barnstaple in North Devon, England.

It can be reached by either rail or automobile in three and a half to four hours from London.

J&S Marine, Ltd., is a member of the Cray Electronics Group, and its place in this organization as of June 1985 is indicated in Figure 1-25.

The Marine Division originated in Crawley and moved to the present location in 1970. Of the current 308 staff, 200 are in Overhaul and Manufacturing on Riverside Road, 80 are in Research and Development and 28 are in the Transducer Group.

Additional Comments: A water-filled measurement tank is available for transducer research and development but is used primarily for quality control tests. The tank, pictured in Figure 1-26, measures 9.84 x 9.84 x 9.84 ft. (3 x 3 x 3 m.) and is Fafnir-lined to reduce problems of reflection. Measurements are limited to frequencies above 5 kHz and generally use sine wave signals at short pulses.

The standard elements used in this tank are the Brüel & Kjaer Type 8104. This unit does not contain a preamplifier and is suitable for use as a reciprocal element serving both as the standard receiving hydrophone and the standard source.

The rotator for the measurement tank is the Brüel & Kjaer Type 3922 turntable, which is synchronized with a Brüel & Kjaer level recorder, Type 2307, supplied with polar plotting paper. (This recorder when used with the standard paper also serves to record the data for hydrophone receiving sensitivities and some transmitting responses.)

The balance of the tank measurement system also consists of Brüel & Kjaer equipment and includes

Sine Random Generator	Type 1027
Power Amplifier	Type 2713
Gating Unit	Type 3922

Other associated equipment for related measurements includes Dranetz complex impedance-admittance meter C1AM-1000C with 1001A and 1004 plug-in units; circle diagram plotter CP-102; Magnetech MIF-1 digital integrating fluxmeter.

As noted earlier, it is anticipated that a new and larger measurement tank will be obtained to be used primarily for acoustic research and development purposes.

At the present time, measurements involving larger units or requiring lower frequencies and/or longer pulses (i.e., most transmitting response measurements) are performed at the Staines Reservoir which is under the control of A.R.E. Teddington (Mr. Donald Fraser, Head N5 Div.)

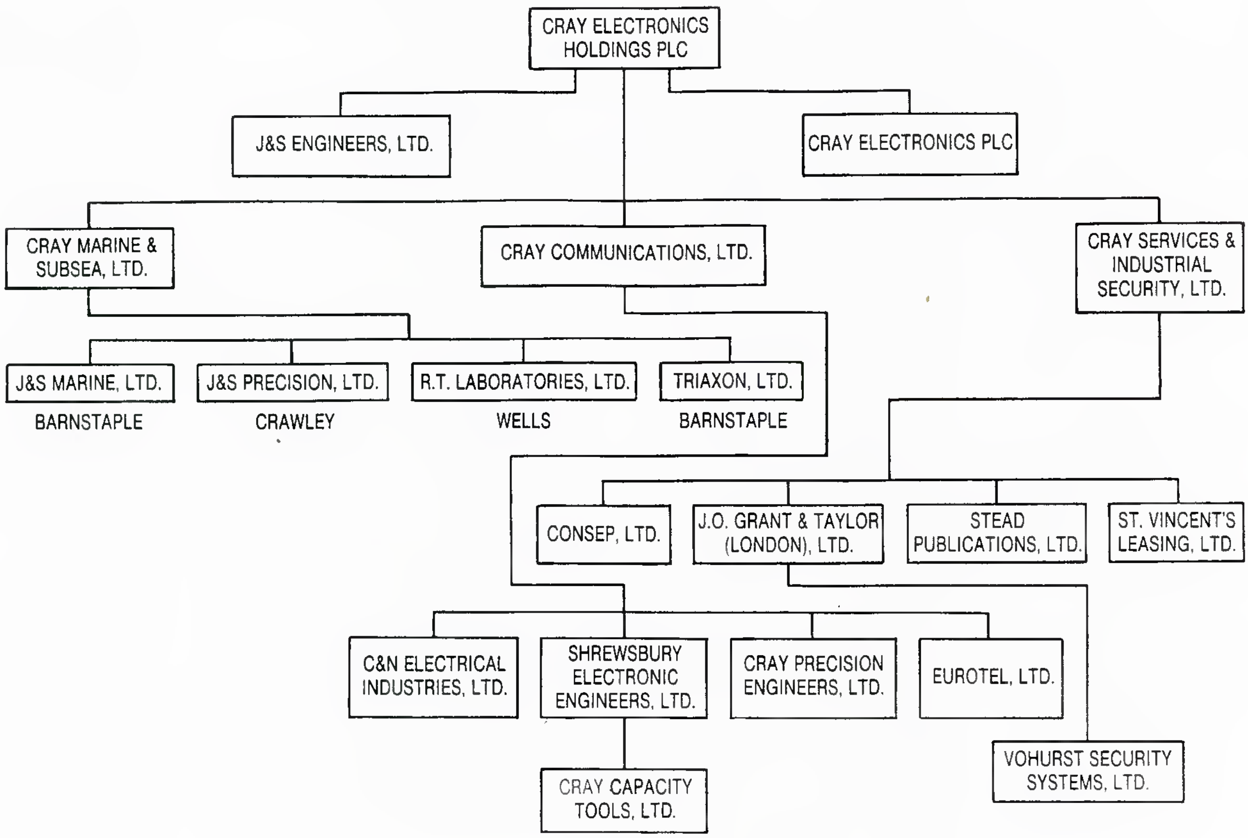


Figure 1-25. Cray Electronics Group Organization

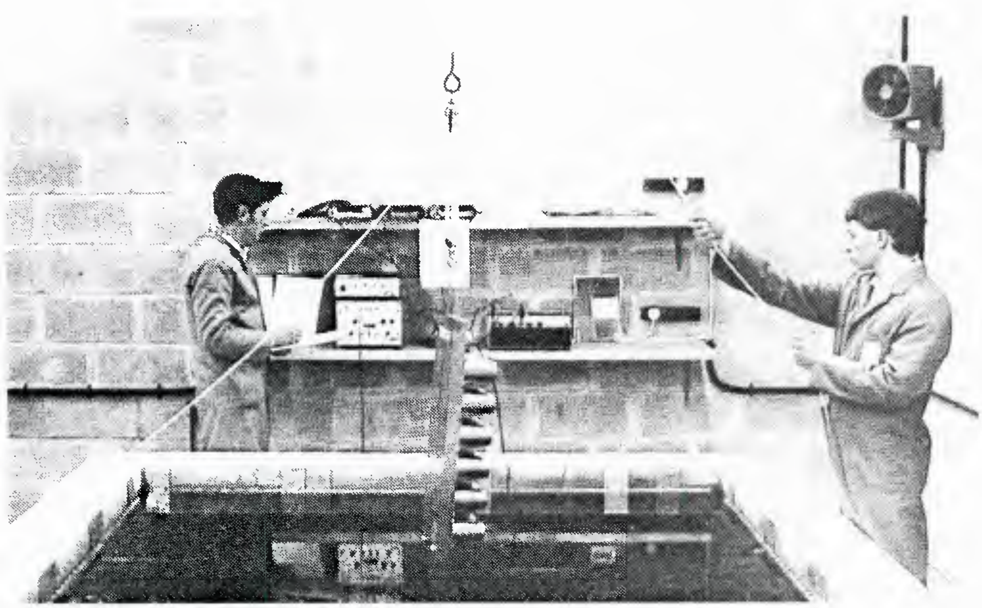


Figure 1-26. Acoustic Measurement Tank

Additional Comments (Cont'd):

Approximately 30% of the business of the Transducer Group is repair and refurbishment (mostly for the Royal Navy) of older sonar equipment. For instance, J&S Marine still winds magnetostrictive scrolls for towed array decoy assemblies for the Navy. This company is essentially the Transducer Repair Facility for the MOD Navy, with an average 9 month turnaround time.

At the same time, this Division produces considerable new sonar equipment, including dunking sonars, underwater telephone systems, mine hunting systems, and other high frequency systems such as side-scan sonars for navigational aids (using cultured quartz sensors).

Facilities for transducer refurbishment and for new construction are excellent with excellent electronic construction facilities including PCB and flow soldering capabilities and well equipped (largely computer-aided) machine shops.

The space currently used for towed array construction is a converted store building with approximately 5000 $ft.^2$/464.5 $m.^2$ of space, about 1.5 mi./2.4 km. from the plant proper.

The current arrays constructed here use PZT_4 cylindrical elements. The array modules have a 3.5-in./8.9-cm. outer diameter (approximately 3-in./7.6-cm. inner diameter) and are made in lengths of either 60 ft. or 100 ft. (18 m. or 30 m.).

A new towed array to be constructed by J&S Marine requires array module lengths of 120 ft./37 m., which lengths cannot be handled in the currently available space. It is planned to move the towed array construction activity to a new site in late 1985 which will accommodate array module lengths up to 130 ft./ 100 m.

Finally, some of the wide variety of acoustic elements manufactured by J&S Marine are shown in Figure 1-27.

Figure 1-27. Some Acoustic Elements Manufactured by J and S Marine, Ltd.

Date of this Summary
25 July 1985

Facility Name: Plessey Marine, Ltd.

Location: Wilkinthroop House, Templecombe, Somerset, England

Cognizant Organization: Plessey Company plc

Facility Functional Name: Plessey Marine Research Unit (PMRU)

Major User(s): Ministry of Defense Navy

Technical Areas Supported: Sonar systems for MOD Navy

Unique Features: Principal supplier of sonar systems to the Royal Navy

Significant Equipment Available: Calibration/measurement barge on remote quarry; laboratory acoustic test tank; injection molding facilities; hydrophone assembly clean room; mechanical shakers; climatic chambers; vacuum chamber; and pressure test vessels

Local Environment: Quiet, small town. (Array calibration barge is on quarry in very remote area.)

Future Plans for Facility: A second, larger, and deeper quarry site for transducer measurements is being considered as a replacement for the quarry currently in use.

Facility Mailing Address: Plessey Marine, Ltd.
Wilkinthroop House
Templecombe
Somerset BA8 ODH
U.K.

Local Contacts: Mr. Paddy Burr
Engineering Manager
Plessey Marine Research Group
At Above Address
Tel: Int. Oper. + 44 + 963-70551

Contact for Access/Scheduling:
Mr. Paddy Burr, as above

Narrative Description: Plessey Marine, Ltd., is located in Templecombe, Somerset, two and a quarter hours by rail from London. Plessey Marine, Ltd., is a company within the structure of the larger Plessey Company plc which includes four major subsidiaries: Plessey Telecommunications and Office Systems (which includes Stromberg-Carlson along with 6 other companies); Plessey Electronic Systems (which includes Plessey Marine along with Plessey Avionics, Plessey Radio Systems, and 7 other companies); Plessey Engineering and Components (which includes 9 smaller companies); and Plessey Worldwide, the international marketing arm of the company. Plessey Co. operates in 131 countries and employs a staff of approximately 41,000 altogether.

Narrative Description (Cont'd):

Plessey Marine, Ltd., is a smaller company of approximately 2000 employees within Plessey Electronic Systems. Of these 2000 employees, approximately 760 are professional engineers.

The 2000 staff members of Plessey Marine, Ltd., are located at the four different locations indicated in Figure 1-28. The engineering staff at each of the four different locations is also given in Figure 1-28.

Additional Comments: Essentially, all of the sonar work for Plessey (other than production) is performed in Templecombe. In Templecombe, Plessey occupies two sites. One is the Wilkinthroop House and the other is the Throop Road facility.

The Throop Road site houses the Technical Director, the Mechanical Engineering Group, Advanced Systems and Prototyping, and among other facilities, the computer aided drawing systems and the acoustic measurement tank.

Wilkinthroop House includes the office of the General Manager, the Basic Research efforts and the Sonar Systems Group.

Altogether, there are about 850 people employed at the two sites in Templecombe working on a wide variety of hydrophones, projectors, and arrays, both active and passive. Approximately 98% of the total effort is for the Ministry of Defense, mostly for the Royal Navy, but with some work in the areas of sonobuoys and dunking sonars performed for the Air Force.

All of the shop facilities necessary for a total sonar system prototyping are available at one site or the other in Templecombe; machine shops, welding facilities, carpentry shop, model shop, photo-optical services, electronics shops, etc.

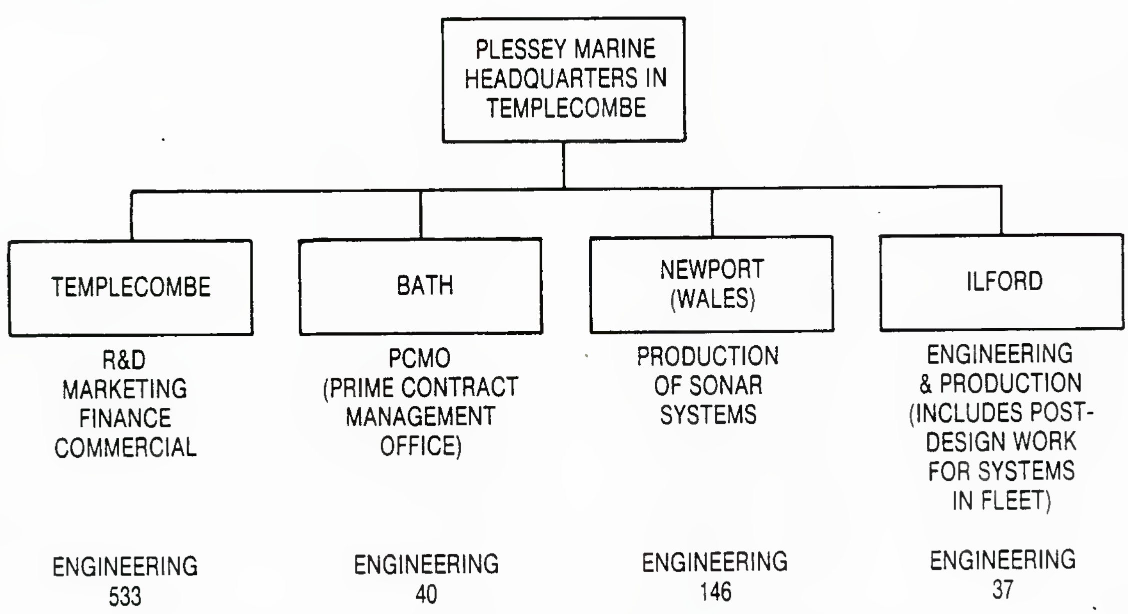


Figure 1-28. Plessey Marine, Ltd., Locations

Additional Comments (Cont'd):

Each department has its own computer facilities. The Mechanical Engineering Department, in which most of the transducer effort is located, utilizes a VAX 11/780 for design and development problems. There are, in addition, a number of smaller computers available for specialized purposes.

The location of the transducer work within the organization is shown in Figure 1-29.

Elements are fabricated in Templecombe using barium titanate, lead zirconate, or lead metoniobate. While the major source for ceramic materials is Channel Industries, other suppliers used include Vernitron and Unilator. (Unilator is in Wales and at one time was a part of Plessey.) The most commonly used material is Channel 5400, especially for elements to be used at lower frequencies. (The lead metoniobate is used mainly for high frequency units to be used at frequencies up to 500 kHz, as the Plessey "2093 Dome Measurement System" or a high frequency sonar developed to search for anchor chains.)

Standard tests of all ceramic material performed on receipt of a shipment include capacitance, coupling coefficiency, tan delta, and dimensional checks.

The ceramic quality checks are performed in the "clean room." This room, located in the transducer assembly area, has controlled air conditioning, humidity control, and air filtration. Other tests performed here include megohmmeter tests of assembled units, solder-joint checks, glue checks, and potting checks. Hydrophone assembly is also performed here.

Also available in the transducer assembly area are vacuum chambers for preparing polyurethane and glues, putting into cartridges, and for removing entrapped air. Ventilation hoods are available for handling noxious materials, as are curing ovens and refrigeration for storing pre-mixed materials.

Facilities are available for injection molding of polyethylene and/or for low temperature molding of polyurethane materials. The polyurethane molding facilities allow for the simultaneous molding of 12 (two sets of 6) items at a time, including ceramic elements, cables, and, where appropriate, preamplifiers.

Located at Throop House is a new Acoustic Test Tank, measuring 13 x 19.7 x 13 ft. deep (4 x 6 x 4 m. deep). The water is chlorinated and the temperature is stabilized at 54.5° ± 1°F (12.5° ± 1°C).

The source fixture is movable and rotatable while the test hydrophone fixture is fixed. The rotator is a Brüel & Kjaer Type 3922 turntable synchronized with a Brüel & Kjaer level recorder Type 2307.

There are two reference hydrophones, both Brüel & Kjaer Type 8100. The standard projectors used are a J-11 and a J-9, both obtained from ACTRAN.

Sine wave short pulses are used for measurements above 5 kHz, and below 5 kHz the J-11 is used, transmitting CW white noise down to 20 Hz. It is felt that the calibrations at low frequencies are good to +0.5 dB and that beam patterns are good to 2°.

Additional Comments (Cont'd):

Reciprocity checks are made on the standards every 6 months.

The power amplifiers used are Analog Associates. There are 10 modules available at 800 watts each.

Other equipment associated with the measurement tank includes:

A computerized accelerometer system which gives automatic readout of phase and magnitude

HP 3582A FFT Analyzer with HP 9816 Floppy Disc System

Dual channel Nicolet Model 660B FFT Analyzer with Maths Option

Other special test equipment includes two large (3.3 x 3.3 x 3.3 ft./1 x 1 x 1 m.) climatic chambers with programmable temperature control.

A third climatic chamber (Ringway Apel, Ltd.) can be cycled from -30° to +80°C and includes a Derritron shaker within the 3.3 x 3.3 x 3.3 ft./1 x 1 x 1 m. chamber.

Two pressure test vessels are located within the laboratory building, both supplied with cable feed-through glands for monitoring equipment under test.

The first is a 1000 psi/68 bars tank, 6.6 ft./2 m. deep with a 1.5 ft./0.46 m. diameter opening. The tank is straight sided with no necking down.

The second tank is a 600 psi/40.1 bars tank, 3.3 ft./1 m. deep, with a 1.7 ft./ 0.52 m. diameter opening. This tank is also straight sided and can be seen in use in Figure 1-30.

A third pressure test vessel is located outside the building and is a horizontal vessel with breech loading. This tank was built originally for testing torpedo sections. It has a pressure limit of 1000 psi/68 bars and is 8 ft./ 2.44 m. long with an inside diameter of 2.5 ft./0.76 m.

Plessey Marine is in the process of obtaining a system which will allow preprogramming of pressure cycling sequences for all three pressure vessels described here.

A smaller high-pressure vessel is also available which, however, does not have electrical access. This is a 20,000 psi/1,360 bars vessel with a 4-in./0.1 m. wall thickness. Inside measurements are 1.5 ft./0.46 m. long and 1 ft./0.3 m. in diameter.

A major facility of Plessey Marine, under the cognizance of the Mechanical Engineering Department, is that identified as the Waterlip In-Water Test Facility. This is a very well equipped test site on a flooded quarry approximately 22 mi./35.2 km. north northwest of Templecombe. It lies between the towns of Shepton Mallett and Frome about 0.75 mi./1.2 km. north of A361. (The turning is 3 mi./4.8 km. east of Shepton Mallett.)

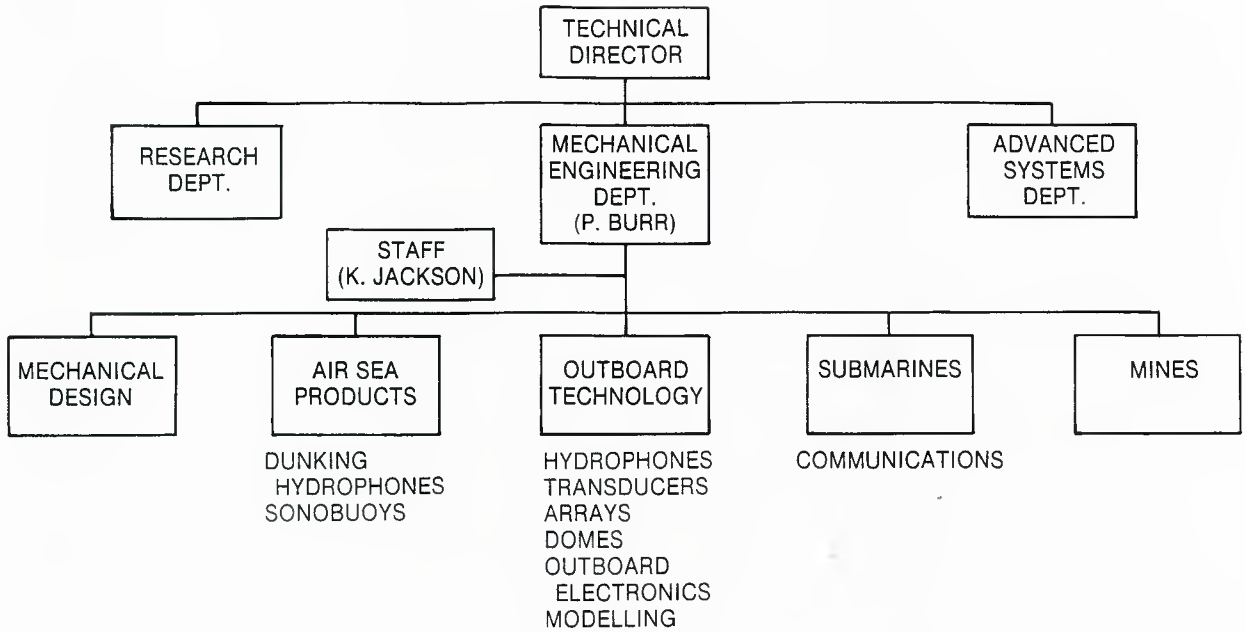


Figure 1-29. Plessey Marine, Ltd., Organization

Figure 1-30. 600 psi Pressure Test Vessel

Additional Comments (Cont'd):

The Lake (the flooded part of the quarry) is generally circular in shape with an area of 10.3 acres/4.2 hektars. The depth is 40 to 60 ft./12.2 to 18.3 m. and is about 50 ft./15.2 m. beneath the floating laboratory. The quarry is in a remote area and is very quiet.

The general layout of the Waterlip site is shown in Figure 1-31. The floating laboratory is reached by descending a steep stairway to a moored walkway which ends at the laboratory.

While the Waterlip site is under the cognizance of the Mechanical Engineering Department, the responsibilities of the Department are limited to the provision of a measurment facility, overhead functions (maintenance, security, cleaning, etc.), fiscal control, logistics, and scheduling when necessary. There is no permanent staff to operate the facility. Each group within Plessey Marine that wishes to use the facility supplies their own operating staff, provides any non-routine instrumentation required, and conducts their own tests, measurements, or calibrations. Between tests, the facility is in a caretaker status with a watchman present but no other staff.

The Waterlip In-Water Test Facility is primarily an array calibration test site. Some life-testing is performed here but generally no dome studies (no concentric shafting) are conducted.

There have been studies on dunking sonars here and studies on sonobuoys (limited by the shallow depths).

A submarine hull simulator at the site is used for submarine self-noise measurements. The simulator consists of a steel cylinder 20 ft./6.1 m. long with a diameter of 5 ft./1.5 m. The simulator will float or it can be submerged to whatever depth desired. The simulator is fitted with pumps, piping, engine mounts, etc. It is also fitted with receiving sensors which can be monitored live topside in the shore instrumentation laboratory.

The Waterlip site has also been used extensively for torpedo launch studies. Most of the installation for this operation remains, including cranes and handling equipment, triple tube launcher, instrumentation hut for torpedo firing, stopping nets, and photographic platforms as indicated in Figure 1-31.

The main compound with workshops and onshore laboratory sits on the edge at the top of the very steep-sided quarry wall. The layout of the main compound is shown in Figure 1-32.

Equipment to be transported to the Floating Laboratory is lowered with the 3.4-US ton/3-British ton crane to a loading float at the bottom which then takes the equipment the 75 ft./23 m. to the laboratory. Other craft available for transport or handling include two rubber boats, one 20-ft./6.1-m. aluminum scow, and two smaller aluminum scows.

The Floating Laboratory is a building, as shown in Figure 1-33, approximately 22 x 16 ft./6.7 x 4.9 m., mounted on two specially designed concrete pontoons each 29.5 ft./9 m. long and 8 ft./2.44 m. wide.

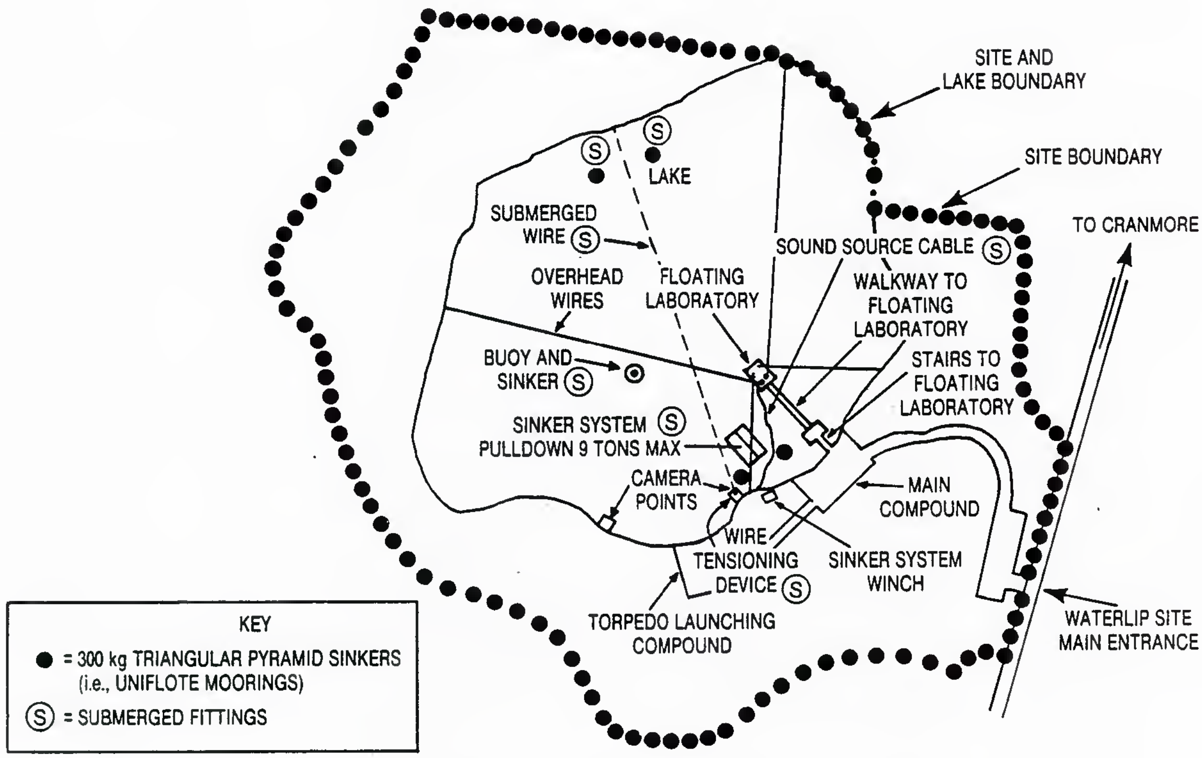


Figure 1-31. General Layout of Waterlip Site

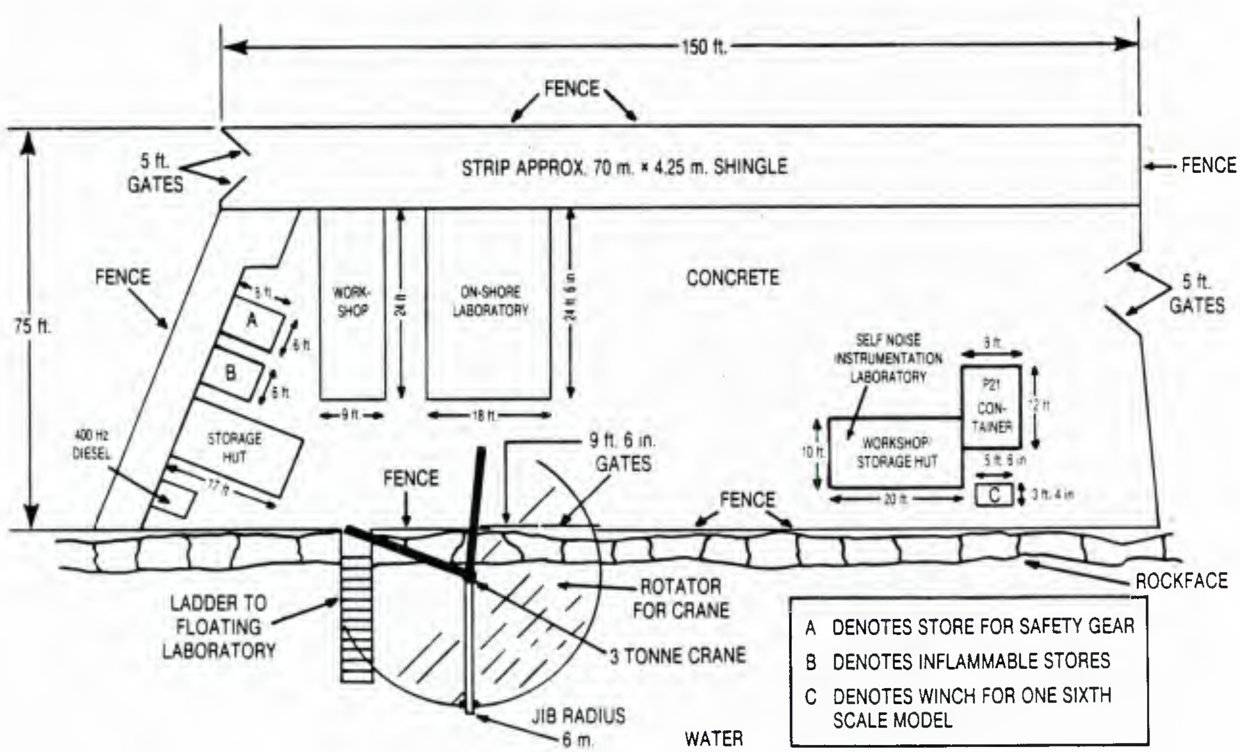


Figure 1-32. Waterlip Site -- Layout of Main Compound

Additional Comments (Cont'd):

The laboratory is divided into a wet end and a dry end by large doors. The wet end contains a well, an opening between the pontoons, which can be accessed by removal of steel floor plates. The well measures 7.5 x 6 ft./2.3 x 1.8 m. and can be entered from the Lake by a small boat with a draft limited to 2.25 ft./ 0.69 m. The limit on the draft is imposed by the pontoon connector seen in the wet end elevation in Figure 1-33. A monorail with a 1.8-US ton/2-British ton hoist runs over the well area and extends 4 ft. 5 in./1.3 m. beyond the end of the pontoons.

The interior of the Floating Laboratory is shown in Figure 1-34.

In general, laboratory users will provide their own instrumentation, depending on the specific tests being made. The identification of one rack in the dry end in Figure 1-34 as Hydrosounder Electronics refers to one of the very few pieces of electronic equipment which is more or less permanently installed. This rack contains the electronics for the primary sound source used at Waterlip; a Gearing and Watson GWA 300-001A Hydrosounder capable of operating down to depths of 50 ft./15.2 m. The electronics rack contains a Gearing and Watson SS 600A Power Amplifier and the associated drive and control modules, including the sweep oscillator unit, the frequency measuring unit, a digital volt/amp meter, and the power supply.

The power amplifier is capable of delivering 600 watts and is connected to the Hydrosounder by a 60-ft./18.3 m. cable. The Hydrosounder itself is limited at some frequencies to a 400 W input (vice the possible 600 W output of the amplifier). Care must be exercised, therefore, not to damage the sound source by overdriving.

The Hydrosounder is a broad band source, with a maximum acoustic output of +165 dB/1 μPa @ 3.3 ft./1 m. It is supported by a shaft on a permanent mount at the end of the pontoon off the dry end of the laboratory.

One other permanently installed system is the rotator and rotator control.

The rotator is permanently mounted off the end of the Floating Laboratory on a pair of Uniflotes, which also provide the support for six 2.2-US ton/2-British ton winches. The rotator is a modified PMS 32 sonar directing gear which can handle loads up to 33.6 US tons/30 British tons.

The rotator control is permanently installed inside the Floating Laboratory.

Power available on the Floating Laboratory includes:

1 Ø	240 V	50 Hz
3 Ø	440 V	50 Hz
3 Ø	24 V 120 V 240 V	400 Hz

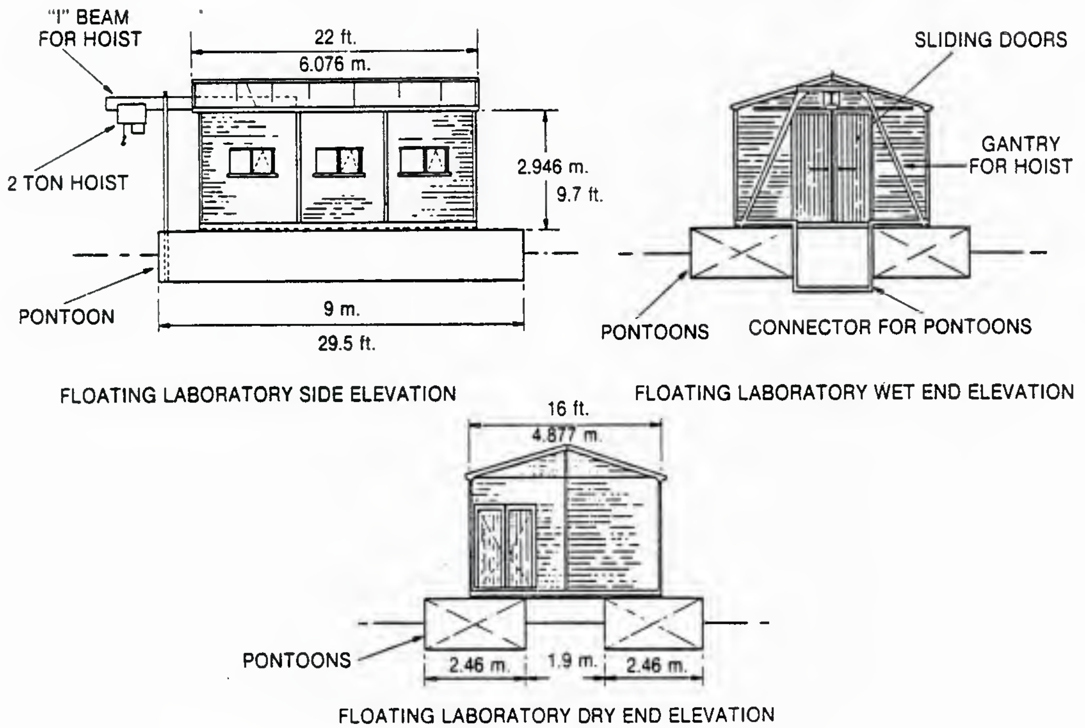


Figure 1-33. Floating Laboratory -- Elevations

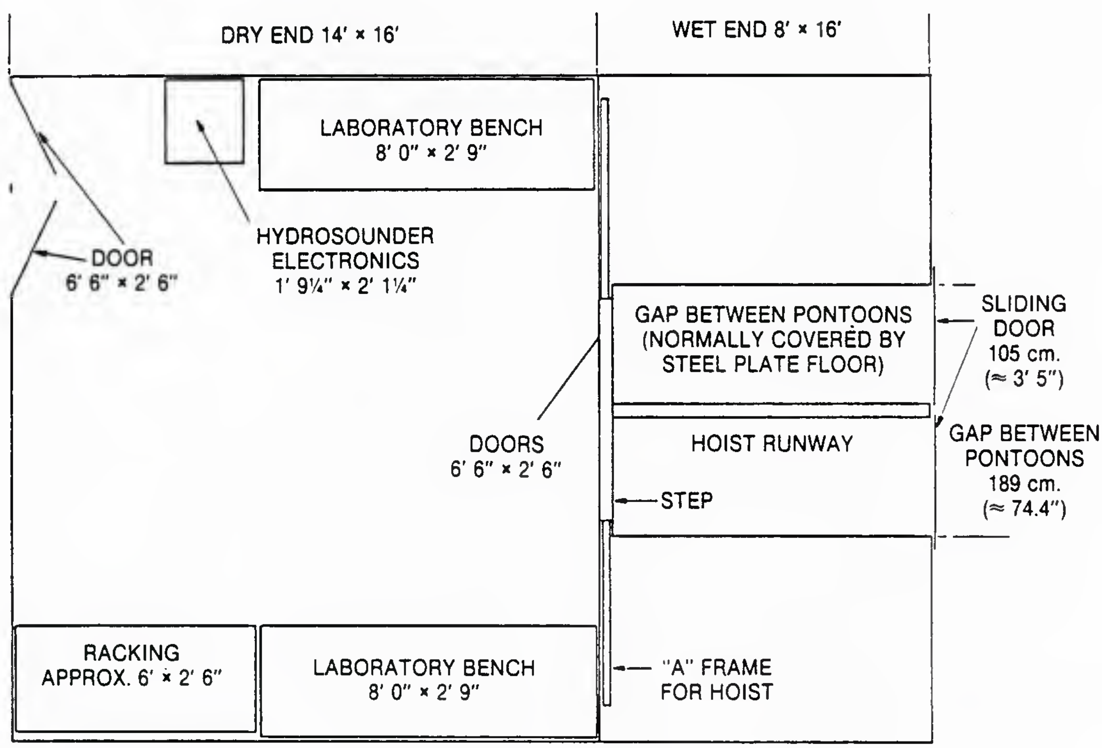


Figure 1-34. Floating Laboratory -- Interior Layout

Additional Comments (Cont'd):

It should be noted also that Plessey Marine is considering a replacement site for the Waterlip facility. The body of water contemplated is also an abandoned quarry called the Vobster Quarry, and it lies about 5 mi./8 km. northeast of Waterlip. It is a larger body of water, approximately 25 acres/10 hektars and is deeper, running from about 80 ft./24 m. at one end to a maximum depth of 200 ft./61 m. towards the opposite end.

Date of this Summary
14 July 1985

Facility Name: Danish Defense Research Establishment (DDRE)
Acoustics Department

Location: Copenhagen, Denmark

Cognizant Organization: Chief of Defense, Denmark (CHOD DEN)

Facility Functional Name: DDRE Acoustics Group

Major User(s): CHOD DEN, Royal Danish Navy (RDN)

Technical Areas Supported: Shallow water propagation, bottom interaction, and ambient noise studies; shallow water acoustic modelling program.

Unique Features: Immediate access to the Baltic Sea and access to the North Sea through the Kattegat and Skagerrak.

Significant Equipment Available: A small transportable instrumentation hut approximately 6 x 7.5 x 9.25 ft./1.8 x 2.3 x 2.8 m.; a wide variety of standard electronic instrumentation is available. A six element hydrophone receiving array with instrumentation buoy and floating tether cable. An array for lowering and firing a series of small charges from the ship. A velocimeter, originally Dyna Empire, but modified by addition of temperature and pressure sensors. An HP 1000 (E/F-series) with ample software and data display facilities.

Local Environment: DDRE is located in Copenhagen approximately 1 mi./1.6 km. from the harbor in a city environment. Measurements are generally made in the Baltic Sea on smaller ships (mine layers) available from the RDN.

Future Plans for Facility: 1) The Acoustic Group is in the process of developing a comprehensive acoustic/oceanographic data base; 2) Continuation of Danish (shallow) water studies; 3) Participation in 1987 Resolute program (Iceland/Greenland) propagation studies; 4) The HP 1000 (E/F-series) computer used ashore for data analysis will be replaced by an HP 1000 (A-series).

Facility Mailing Address: Danish Defense Research Establishment
Ved Idraetsparken 4
P.O. Box 2715
DK-2100 Copenhagen Ø
Denmark

Local Contacts: Mr. Tage Strarup, M.Sc.
At the above address
Tel: Int. + 45 + 1 42 57 07 Ext. 278

Contact for Access/Scheduling: Mr. Tage Strarup, M.Sc. (as above)

Narrative Description: Organizationally, DDRE is located as shown in Figure 2-1(a) below. Physically, it is located on Ved Idraetsparken just under 1 mi./1.6 km. from the harborside in Copenhagen. The establishment structure and reearch activities are shown in Figures 2-1(b) and 2-1(c), respectively.

Narrative Description (Cont'd):

The Acoustics Group consists of four members headed by Mr. Tage Strarup, M.Sc.

Two recent measurement programs involving this group have been the Danish Waters Program (propagation loss, sea floor reflectivity, and ambient noise studies) and the Shallow Meadows Program (propagation loss and reflectivity studies).

Participation in the Resolute Support Program is planned for 1987 in Icelandic and Greenland waters.

A normal year will include one or two sea trials on whatever vessel is available or necessary in accordance with the approved research program. The seagoing equipment necessary to accomplish such sea trials is maintained in an operational ready condition at DDRE.

DDRE is responsible for research and evaluation in specific technical areas and provides a basis for Defense Headquarters long-term planning. Special areas include aspects of detection, communication, control, and CCIS and electronic warfare, weapon systems effectiveness, and force structure analysis.

DDRE is the formal organization for all defense research (but not development) and is the point of contact for international research cooperation.

The sources used for both transmission loss measurements and for the sea floor reflectivity measurements are explosive charges. Such charges vary in size from the 0.04 oz./1 gm. detonators used during the Danish Waters Program to the 7 oz./200 gm. charges used in the Shallow Meadow Program. (The 0.04 oz./1 gm. sources were electrically detonated and the 7 oz./200 gm. charges were detonated with lit fuses.)

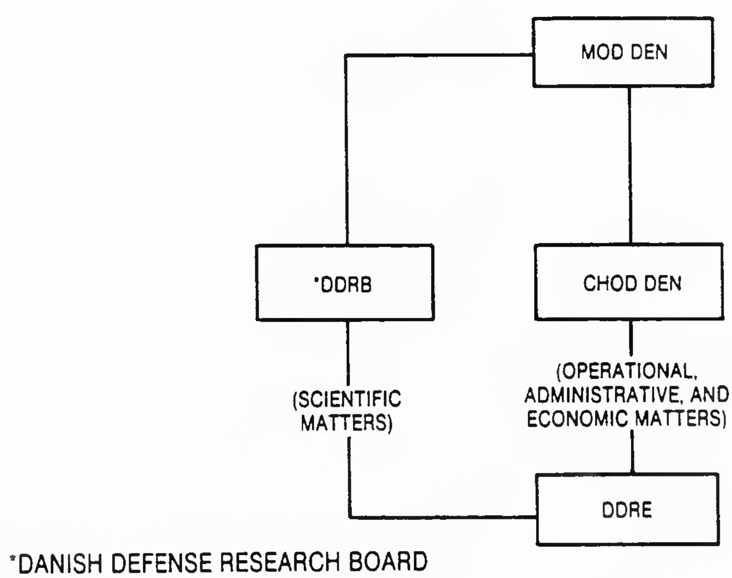


Figure 2-1(a). DDRE in the National Structure

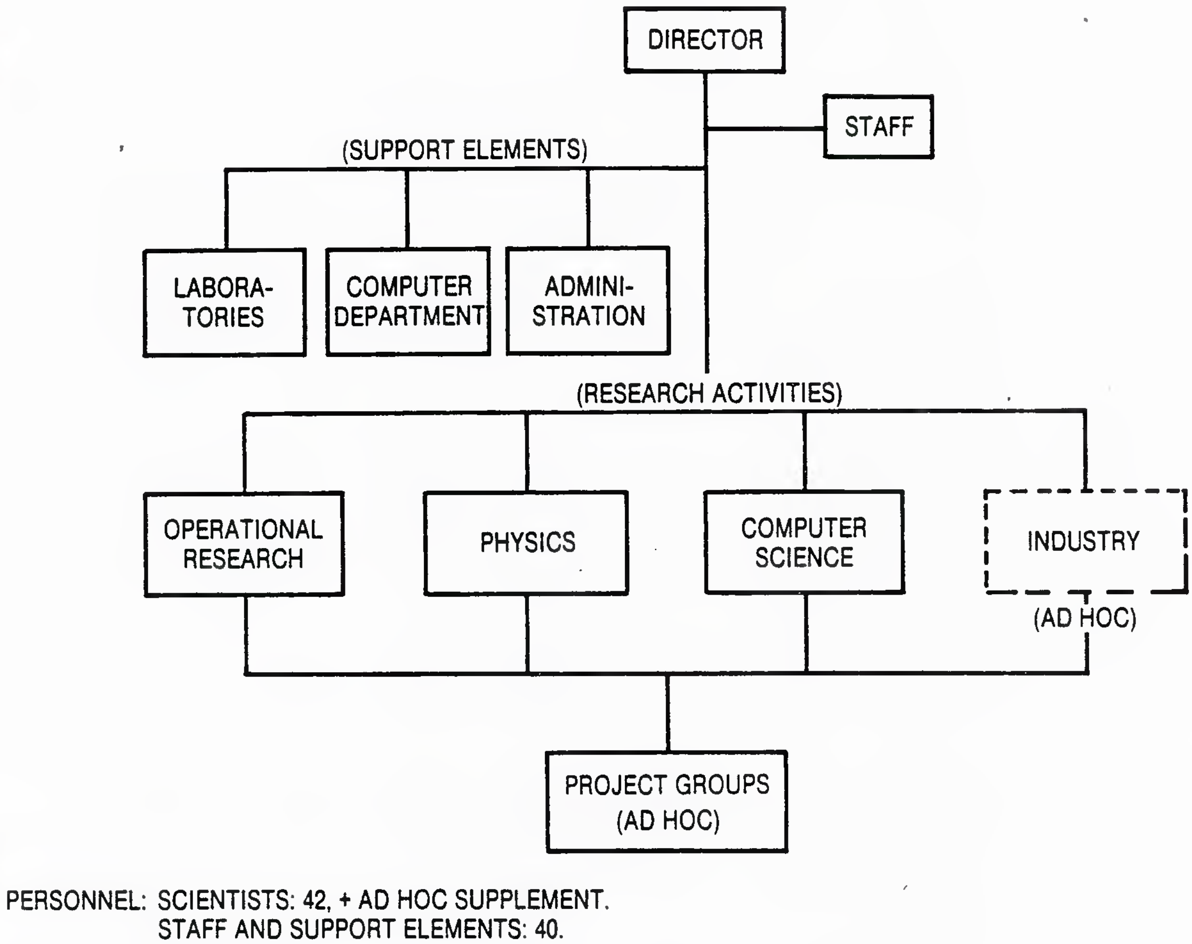


Figure 2-1(b). Structure of DDRE

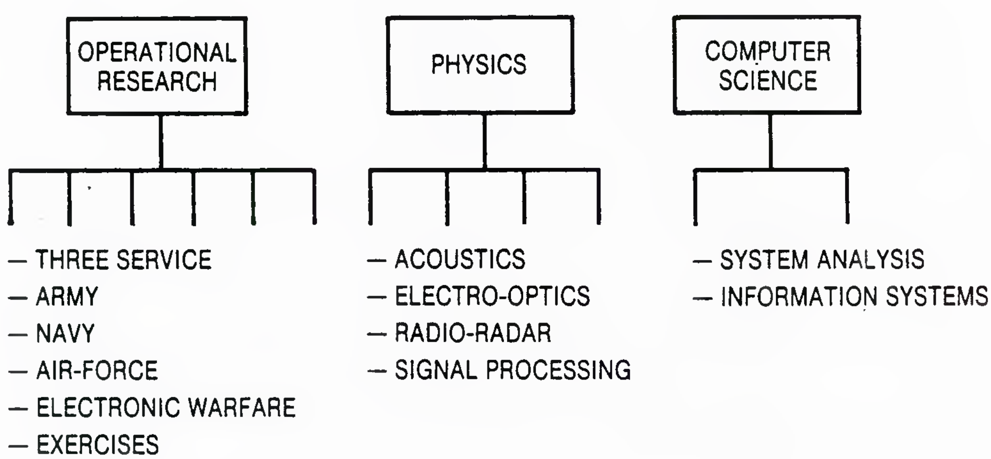


Figure 2-1(c). Research Activities of DDRE

Narrative Description (Cont'd):

The configuration for the receiving ship during the transmission loss measurements is shown in Figure 2-2.

Water depths during the transmission loss measurements in the Baltic vary from 98 to 328 ft./30 to 100 m., while water depths in the Danish Waters tests are generally about 33 ft./10 m.

The receiving elements in the array for the transmission loss measurements are the Brüel & Kjaer Type 8101 hydrophone with preamplifier included in the hydrophone case. There are three stacked outputs from each receiver position encompassing a 110 dB dynamic range.

The DDRE-designed and built spar type instrumentation buoy contains an A/D converter which selects the optimum gain channel from each hydrophone position. The buoy also contains a prefiltering circuit with the characteristics shown in Figure 2-3.

The digitized data are transmitted over the air-filled floating cable to the receiving ship.

The velocimeter used is a modified Dyna Empire unit. The modifications include the addition of temperature and pressure sensors to the velocity sing-around circuit. Salinity, which is a significant parameter due to the strong salinity gradient in the Baltic, is calculated from the velocity, pressure, and temperature data. A full surface-to-bottom profile is measured in each case.

The position of the receiving ship is fixed during the above transmission loss measurements, while the source ship (or aircraft) opens range, dropping explosives at designated ranges (1 nmi./1.8 km.).

The measurement configuration for the single ship sea floor reflectivity measurements is shown in Figure 2-4.

Again, a full surface-to-bottom velocity profile is measured for each reflectivity measurement, using the same unit described above.

The various combinations of hydrophone and detonator depth permit a satisfactory range of reflection angles.

The receiving elements used for the reflectivity measurements are the small Brüel & Kjaer Type 8103 hydrophones with extra long cables attached.

The seagoing computer, an HP 1000 (E/F-series), and the other measuring equipment can be installed within a transportable instrumentation hut at DDRE prior to the sea tests. The hut is aluminum sheathed and measures 5.9 ft. high x 9.3 ft. long x 7.7 ft. wide/1.8 m. high x 2.8 m. long x 8.5 m. wide. It is fitted to accept relay racks and has tables for additional equipment and for work space. Power receptacles for 220 V and 110 V AC plugs are provided within the hut and the hut is powered from external power cables.

The instrumentation hut is also provided with lifting padeyes on the roof for lifting by crane for transport and for installing on shipboard.

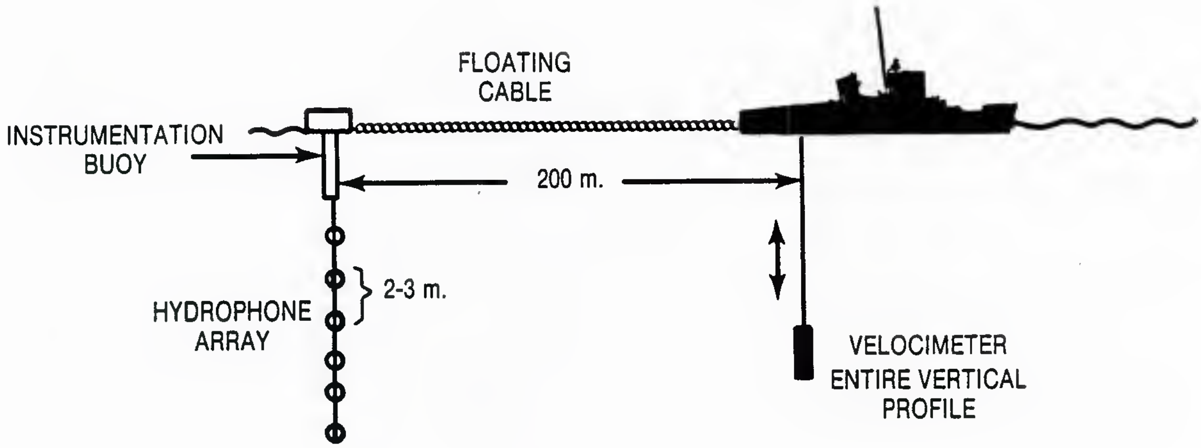


Figure 2-2. Configuration for Receiving Ship

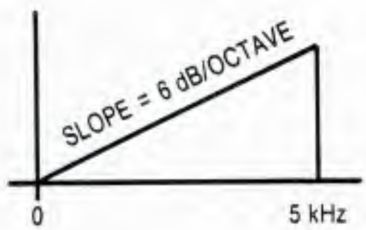


Figure 2-3. Characteristics of Prefiltering Circuit

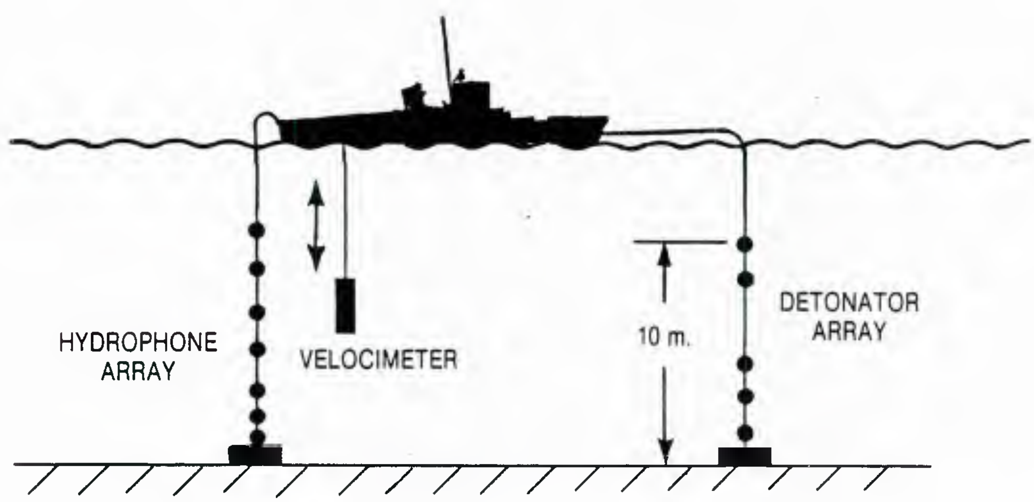


Figure 2-4. Single Ship Sea Floor Reflectivity Measurements Configuration

Narrative Description (Cont'd):

Ashore an HP 1000 (E/F-series) system (soon to be replaced by an HP 1000 (A-series) computer) is available for data analysis.

The DDRE central computer is a Digital Equipment Corp., VAX 8650/8200.

There is also a versatile digital recording and display system for use with the HP 1000 system which includes a GRINNEL SYSTEM disc file data-to-video translator, a BARCO Video Display with cursor (zoom) control, a SONY Video Recorder/Playback machine and a BARCO playback screen.

Other facilities available at DDRE include: machine shop and sheet metal facilities; carpentry facilities; photographic and duplicator facilities; electrical wiring services; and instrument-repair, calibration and storage facilities.

In addition to the acoustic measurement and survey work, there is a significant shallow water modelling effort underway at DDRE and a current effort toward developing an Acoustic Data Base.

For further information regarding the MOPSATH Model (MOnoPole Source Array THeory), contact Mr. Tage Strarup at the above address.

Date of this Summary
13 May 1985

Facility Name: Søvaernets Taktikskolen

Location: Holmen, Copenhagen, Denmark

Cognizant Organization: Danish Navy

Facility Functional Name: Taktikskolen

Major User(s): Danish Navy

Technical Areas Supported: Acoustic propagation, ambient noise

Special Programs Supported: NATO and national oceanographic/acoustic surveys

Unique Features: Access to ships, oceanographic instrumentation and associated equipment. Contact for Northsea Fisheries R&D Center through this office. Danish Navy schools and inspection offices.

Significant Equipment Available: Current meters, velocity profilers, and measuring platforms

Local Environment: Danish Navy offices in Copenhagen

Future Plans for Facility: None specified.

Facility Mailing Address: Søvaernets Taktikskolen
Holmen
DK-1433 Copenhagen K
Denmark

Local Contacts: Captain Grentzman at above address
Commander Bech
Tel: Int. Oper. + 45 + 1 5413 13 Ext. 2086 or 2087

Contact for Access/Scheduling: As above

Date of this Summary
13 May 1985

Facility Name: Søvaernets Materiel Kommando

Location: Holmen, Copenhagen, Denmark

Cognizant Organization: Danish Navy, Danish Defense Command

Facility Functional Name: Materiel Kommando

Major User(s): Danish Navy

Technical Areas Supported: Ship/submarine, machinery noise quieting

Unique Features: None indicated

Significant Equipment Available: Accelerometers fixed on machinery foundations as well as movable magnetic mounting accelerometers. Instrumentation (not identified) for making FFTs of the accelerometer data. Brüel & Kjaer hydrophone and associated B&K instrumentation for overside measurements.

Local Environment: Navy buildings, Holmen, Copenhagen

Future Plans for Facility: None specified.

Facility Mailing Address: Søvaernets Materiel Kommando
Holmen
DK-1433 Copenhagen K
Denmark

Local Contacts: Overingenior Torben Munk
At the above address
Mr. E. Bauch
Tel: Int. Oper. + 45 + 1 54 13 13

Contact for Access/Scheduling: Overingenior Torben Munk (as above)

Narrative Description: This group in the Søvaernets Materiel Kommando is involved primarily with the problems of machinery noise quieting on submarines and ships (mainly submarines).

The group makes measurements routinely with fixed and movable accelerometers within the submarine, generating spectra of the accelerometer data.

Two hydrophones are permanently located in the free-flooding areas of the submarine(s), but turbulent noise in this area has rendered them largely unusable.

A Brüel & Kjaer hydrophone with associated B&K measurement equipment is also available as an overside supplement to the internal accelerometer measurements on submarines.

Narrative Description (Cont'd):

In general, the Materiel Kommando group does not make acoustic measurements, but turns to Mr. Tage Strarup at DDRE and/or Professor Bjørnø at the University for advice and assistance.

Submarine radiated noise measurements, both static and underway, are generally made at the Aamøy measurement range off Stavanger in Norway. Submarines normally run this range at 16 knots at a depth of 98 ft./30 m. Data are recorded by the Aamøy station personnel.

Static (suspended) measurements are generally made at night for reasons of reduced background noise. All rotating machinery (excepting propulsion machinery) is operated one at a time and other possible noise sources (periscope operation, etc.) are examined.

If it should be necessary to make underway radiated noise measurements on surface ships, such would be accomplished at the Aschau Range off Eckernforde in Germany, arrangements permitting.

Date of this Summary
8 May 1985

Facility Name: Industrial Acoustics Laboratory

Location: Building 352, Technical University, Lyngby, Denmark

Cognizant Organization: Technical University of Denmark

Facility Functional Name: Industrial Acoustics Laboratory

Major User(s): Danish Navy, Danish Defense Research Establishment, Danish Industry

Technical Areas Supported: Transducer development, development of improved measurement/calibration facilities and techniques

Special Programs Supported: High frequency study of fish reflectivity

Unique Features: Facilities for high frequency self-reciprocity calibration. Facilities for time-delay spectrometry calibration.

Significant Equipment Available: Wide frequency band anechoic measurement/calibration tank (29.5 x 29.5 x 23.6 in./75 x 75 x 60 cm.); steel tank (118 x 79 x 79 in./300 x 200 x 200 cm.); plastic tank (84.6 x 31.5 x 31.5 in./215 x 80 x 80 cm.); and glass tank (15.7 x 15.7 x 31.5 in./40 x 40 x 80 cm.).

Local Environment: Large University campus in a quiet city (Lyngby) north of Copenhagen.

Facility Mailing Address: Industrial Acoustics Laboratory
Institute of Manufacturing Engineering
Technical University of Denmark
Building 352
DK-2800 Lyngby
Denmark

Local Contacts: Professor Leif Bjørnø, at above address
Tel: Int. Oper. + 45 288 25 22

Contact for Access/Scheduling: Professor Leif Bjørnø (as above)

Narrative Description: Professor Leif Bjørnø is well known world-wide in the underwater acoustics community. As head of the department, the facilities of the Industrial Acoustics Laboratory in the Institute of Manufacturing Engineering at the Technical University of Denmark are under his cognizance.

The Technical University can be divided into four areas of engineering study: Chemical, Mechanical, Civil, and Electrical. The Industrial Acoustics Laboratory falls within the Mechanical Engineering area and, in turn, can be subdivided into four major areas of department concern:

1. Transducer Development
2. Mechanical Noise

Narrative Description (Cont'd):

3. Medical and Industrial Ultrasonics
4. Robot Sensors

The Industrial Acoustics Laboratory maintains close contacts with Danish industry and there is a constant interchange of ideas in the continuing conversation between the two. As might be expected, each of the four areas of effort indicated above is industrially oriented.

The Transducer Development effort is largely concerned with hydrophones, and other sensors to be used primarily for control of industrial process, sensing such parameters as flow and pressure.

The Mechanical Noise effort includes studies of various (industrial) noises and their sources and attempts to control such noises. Normally included are studies of flow noise, combustion noise, engine noise, and structural vibration.

Ultrasonics for Medicine include development of sensors for monitoring various functions such as heart and lung sounds, blood pressure, blood flow, etc., for investigative diagnoses (imaging, tissue reflectivity) and effects of ultrasonics on human tissue.

Ultrasonics for industry is concerned primarily with the processes and techniques of cleaning and non-destructive testing.

Robot sensors again are intended to control some process performed by a machine/robot and generally involve sensing a distance or following a line or an edge or performing a scanning search process, or some other such programmable operation.

Additional Comments: A chart summarizing the measurement tanks available at the Laboratory, the measurement techniques used with each tank and the frequency range covered was prepared by Niels Kjaergaard, a graduate student assisting Professor Bjørnø and is duplicated on the following page.

Two relevant references are: "A Wide Frequency Band Anechoic Water Tank," by L. Bjørnø and M. Kjeldgaard, ACUSTICA 1975, Volume 32, No. 2; and "Calibration and Performance Evaluation of Miniature Ultrasonic Hydrophones Using Time Delay Spectrometry," by Peter A. Lewin, IEEE, 1981, Ultrasonics Symposium.

The laboratory is well supplied with modern instrumentation and, as might be expected in a University Laboratory, the equipment arrangement is entirely fluid.

The Laboratory computers and those used with all the calibration tanks were two Commodore CBM Model 8032 Digital Systems with keyboards and monitor screens, CBM Model 4022P Tractor Printers, and the CBM Model 8050 Dual Drive Floppy Disk. It was expected that the 8032 system normally used with the calibration tanks would be replaced by a Commodore 64 by the time of this writing. Two newer and more sophisticated computer systems recently acquired by the Laboratory, which provide increased computational power, are an HP 9000 Series 300 and an Olivetti M24 SP.

Additional Comments Cont'd):

FAR-FIELD CALIBRATION METHOD USED	TANK USED Length × Width × Height	FREQUENCY in kHz
Three transducer reciprocity with single frequency short pulses	Anechoic Tank 75 × 75 × 60 cm.	10 kHz - 300 kHz
	Steel Tank 300 × 200 × 200 cm.	5 kHz - 200 kHz
	Plastic Tank 215 × 80 × 80 cm.	30 kHz - 500 kHz
Comparison calibration using Time Delay Spectrometry. (An FM sweep over the band of interest is transmitted. Reception is accomplished through a narrow filter, swept through the same frequency band after the appropriate delay.)	As Above	
Two transducer calibration method. (Still in development, this method involves a self-reciprocity calibration of a reciprocal element using a reflecting plate. The hydrophone to be calibrated is then placed in the known sound field and calibrated using the Time Delay Spectrometry method described above.)	Glass Tank	500 kHz - 20 MHz

Other instrumentation available at the laboratory is listed below.

Data Recorder	Penny and Giles	PG 2100
X-Y Plotter	Kipp and Zonen	BD 30 X-Y-t
Pulse/Sweep Function Generator	Exact	Model 516
Function Generator (10 kHz - 2 MHz)	Phillips	PM 5133
Gating Box	Brüel & Kjaer	
Gating System	Brüel & Kjaer	Type 4440
(Includes transmit pulse rate and width and receive measuring gate)		
Measuring Amplifier (1 Hz - 200 kHz)	Brüel & Kjaer	Type 2636
(Includes preamplifier, high pass, low pass, bandpass filters, RMS reading, peak reading, and IEC/IEEE interface for digital readout.)		
Pulse Modulator and Receiver	Matec	Model 6600
With Matec RF Plug-In (10-90 MHz)		Model 760
and Matec RF Plug-In (1 MHz-20 MHz)		Model 755
Eight Channel Multiplexer	Brüel & Kjaer	Type 2811
Bandpass Filter	Brüel & Kjaer	Type 1617
Phase Meter	Brüel & Kjaer	Type 2971
Two-Channel Microphone Power Supply	Brüel & Kjaer	Type 2807
Charge Amplifier	Brüel & Kjaer	Type 2635
Conditioning Amplifier	Brüel & Kjaer	Type 2650
Counter and Timer	Fluke	Model 1953
Storage Oscilloscope	(Japanese Mfr.)	DSS 6521
Spectrum Analyzer	Hewlett-Packard	Model HP 3585A
Power Amplifier	Brüel & Kjaer	Type 2713
Power Amplifier (250 kHz-110 MHz)	ENI	Model 300L
Power Amplifier (7 kHz-250 kHz, 2000 W)	ENI	Model 1140L
Power Amplifier (10 MHz, 200W into 50Ω)	ENI	Model 240L
Dual Channel Signal Analyzer	Brüel & Kjaer	Type 2032

Date of this Summary
6 May 1985

Facility Name: Reson System ApS.

Location: Hilleroed, Denmark

Cognizant Organization: Reson System ApS. (Commercial, independent)

Facility Functional Name: Production plant with all associated research and development facilities

Major User(s): Oil Companies

Technical Areas Supported: Transducer research and development and production

Unique Features: Large high pressure test vessel, automated computerized calibration facility for measurement in a 5 kHz to 2.1 MHz frequency range

Significant Equipment Available: Hydrophone calibration and test tank with all digital peripheral equipment; transducer fabrication and test equipment; and computerized hydrophone/transducer design capabilities

Local Environment: Rural, very quiet

Future Plans for Facility: Add near-field scanner system. Improved handling for pressure vessel (installed since this review was conducted).

Facility Mailing Address: Reson System ApS.
4 Attemosevej
DK-3400 Hilleroed
Denmark

Local Contacts: Mr. Per Steenstrup, Technical Manager
Tel: Int. Oper. + 45 + 2-265240

Contact for Access/Scheduling: Mr. Per Steenstrup, as above

Additional Comments: Reson System ApS. is a small Danish company located north of Copenhagen about 5 mi./8 km. outside the town of Hilleroed, at 4 Attemosevej. The company builds and sells a wide variety of hydrophones and transducers which appear to be of a very high quality.

They speak of themselves as being primarily involved in ultrasonics and in fact do build units and associated electronics to operate at frequencies up to 10 MHz, but they also build units operating in the 3-5 kHz region and of course build hydrophones to be used at frequencies down to 1 Hz.

Reson does not do non-destructive ultrasonic testing or cleaning, but they do provide transducers to companies that do such testing and/or cleaning. Neither is Reson involved in medical ultrasonics or in medical testing in general.

Additional Comments (Cont'd):

Their major customers are the oil companies, particularly the oil prospecting divisions and the undersea pipe laying divisions. Other customers include the navies of several countries.

One item manufactured by Reson in Hilleroed and described as their "bread and butter" product is an ultrasonic homogenizer, used for agitating water/crude oil mixtures (on the order of 5% water) to create the desired emulsion for hotter, cleaner and more efficient combustion in stationary steam plants and in diesel engines. Each of four ultrasonic transducers is driven by a 200 watt, 90% efficient power amplifier with a self-adapting output impedance feature that matches the impedance of the transducer, which in turn sees a changing load.

The entire production of the company is housed in a half-dozen ex-farm buildings located about 5 mi./8 km. from the town. All of the R&D is also performed at this facility.

The company was founded by Mr. Per Resen Steenstrup who continues as Technical Manager and is aided in the operation of the company by two brothers, Claus and Jens, and approximately 15 employees. Mr. Steenstrup was a 1975 graduate of the Technical University of Denmark and was a student of Prof. Leif Bjørnø with whom he still maintains contact.

Company philosophy is to subcontract all production work other than assembly and testing. All development work is done in-house at Reson System facilities.

All hydrophones and projectors are of ceramic construction, normally PZT. Reson System purchases the ceramic to their specifications, pre-formed, silvered and polarized. (They do not buy any bulk ceramic materials.) The ceramic is thoroughly tested in terms of capacitance and impedance and for adhesion of the silvering.

All soldering, installation of preamplifiers, potting, cable attachment and hydrophone testing is performed on-site at the Reson System facilities. All potting and all protective boots are made of one form or another of polyurethane, and all cables used are polyurethane jacketed. (Although the facility is available on-site; very little oil filling is done.)

The company has developed a large number of successful computer programs for the design and construction of hydrophones, transducers and small arrays. As a consequence, there is very little prototyping necessary which is an asset in terms of initial design costs and in turnaround time.

The company is currently in an expansion process, but only in terms of marketing. At this point, all final production and testing as well as R&D is still performed at the Hilleroed facilities. Two marketing arms at the company are being set up; one in the U.S. and one in the U.K.

Additional Comments (Cont'd):

The U.S. company is identified as:

Acoustic Transducers, Inc.
600 Firestone Road
Goleta, CA 93117
Tel: (805) 964-6260

and is now operated by the brother, Jens Steenstrup. Since this review was written, some R&D and some production have been undertaken at the Goleta facility.

The U.K. company is identified as:

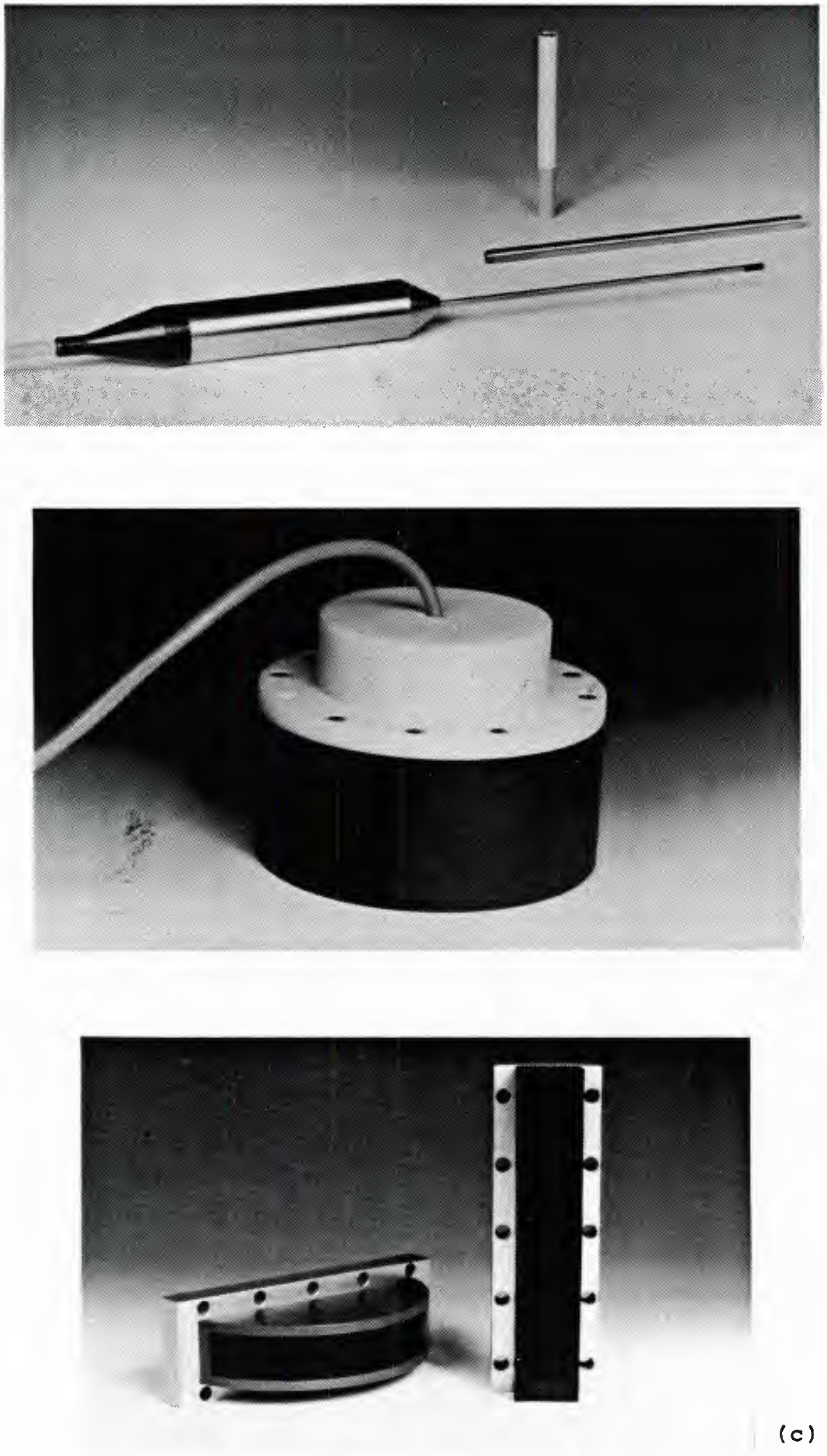
Echotronics Unlimited
31a St. George Street
London WIR 9FA
Tel: 01-493-3332

and is operated by the brother, Claus Steenstrup, with Mr. George Werner serving as Chairman and Managing Director.

There are two capabilities particularly relevant to this register at the Reson System facilities in Hilleroed which will be further described in the following separate entries.

1. High Pressure Test Vessel
2. Transducer Calibration and Test Tank

Three examples of the products of Reson System are given in Figure 2-5. Figure 2-5(a) at the top is a PZT 1 MHz high capacitance hydrophone with preamplifier and protective guard. Figure 2-5(b) is a 33 kHz echosounder transducer and Figure 2-5(c) at the bottom is a 200 kHz, 40-element phased array. The curved (100° beam) transmitter is on the left and the receiver is shown on the right.



(a)

(b)

(c)

Figure 2-5. Examples of Reson System ApS. Products

Date of this Summary
6 May 1985

Facility Name: High Pressure Test Vessel

Location: Reson System ApS., Hilleroed, Denmark

Cognizant Organization: Reson System ApS.

Facility Functional Name: 8800 psi Pressure Vessel

Major User(s): Reson System ApS., oil/gas companies, other contractors

Technical Areas Supported: Transducer development

Unique Features: Large capacity and high pressure test capability

Significant Equipment Available: High pressure pump (22050 psi/1500 bars)

Local Environment: Rural, very quiet

Future Plans for Facility: Installation of handling equipment for cover (200 lb./400 kg.) closure/opening and for handling heavier items under test.

Facility Mailing Address: Reson System ApS.
4 Attemosevej
DK-3400 Hilleroed
Denmark

Local Contacts: Mr. Per Resen Steenstrup, Technical Manager
At the above address
Tel: Int. Oper. + 45 + 2-265240

Contact for Access/Scheduling: Scheduling for use of the high pressure test vessel should be through Mr. Per Steenstrup at the above address.

Narrative Description: The Reson System ApS. high pressure test vessel is described as Europe's largest. See Figure 2-6 on following page.

The internal dimensions are:

Diameter: 12.6 in./32 cm.
Length: 6.56 ft./2 m.
Weight: 5.75 US tons/5.13 British tons

The internal pressure capability is: 8820 psi/600 bars.

The diameter is uniform throughout the length of the vessel, with no necking down at the vessel opening.

Cable access is through the cover. There are three cable "through-puts" or removable plugs in the cover. Reson System passes a .33 in./8.4 mm. diameter, polyurethane-jacketed, 2-conductor shielded cable through any one or more of

Narrative Description (Cont'd):

the ports. The Reson System cable is then spliced to the cable attached to the item under test. Cable entry seals are provided by Reson System.

The vessel cover is sealed by two O-rings and is simply lowered into the vessel until it rests on a shoulder machined into the vessel. There are no bolts or nuts to be loosened or tightened. Three semi-circular 2-in./5.1-cm. thick keys are inserted into the vessel wall at the top of the cover to prevent the cover from being forced out under pressure.

The high pressure tank is all forged steel with no welds. It is normally operated with a water temperature of 68° F/20° C, and the outside of the tank is thermally insulated. (The tank can be used at other water temperatures if desired, although there are not currently ready facilities for heating or chilling the water.)

The tank is filled initially from a 79.3 gal./300 liter storage tank containing treated water, pumping in at the bottom of the tank to a pressure of 140 psi/9.5 bars. This initial filling takes about 10 minutes including time for the water to be circulated through the tank for removal of entrapped air bubbles.

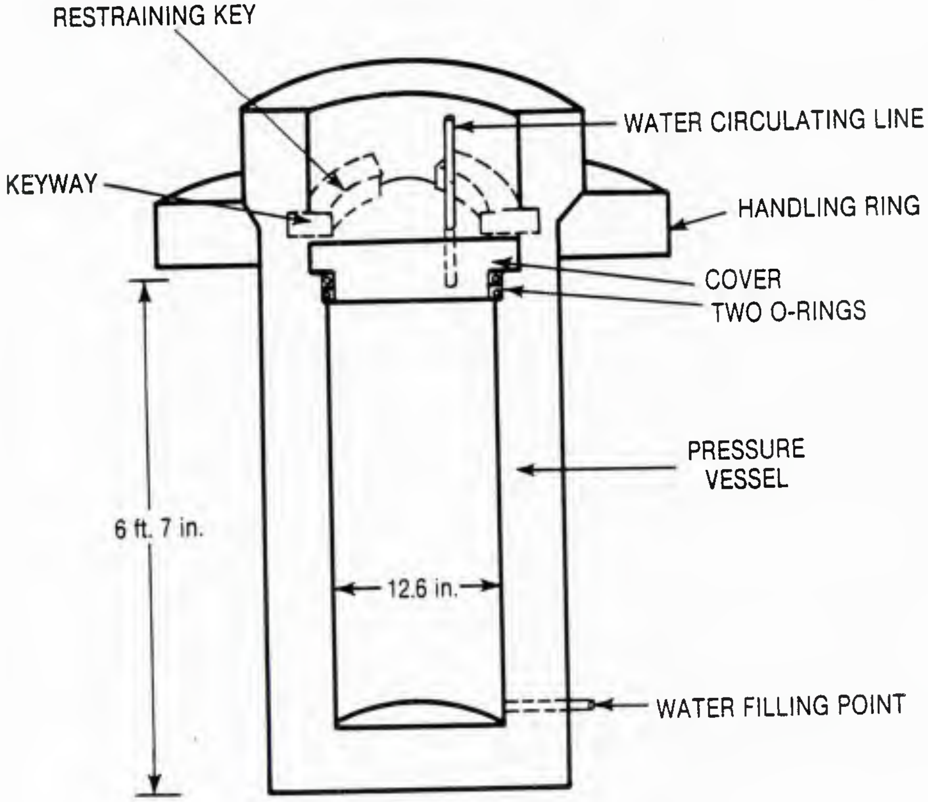


Figure 2-6. 8820 psi Pressure Vessel

Narrative Description (Cont'd):

After filling and circulating, the 140 psi/9.5 bars pump is secured and a high pressure water pump operated by compressed air (with a 200:1 pressure gain) completes the pressurization (to a maximum of 8820 psi/600 bars). The final pressurization phase requires only about 1 minute. The filling and pressurization process is diagrammed in Figure 2-7.

Although other measurements can be made, the only one routinely made on units being tested in the pressure tank is that of impedance. It is felt that impedance is an adequate indicator of a failure or degradation of performance of any of the units normally tested and is monitored throughout all tests.

Currently, the cover of the tank, which weighs approximately 200 lb./90.7 kg. is handled manually. This is somewhat awkward although it certainly does not interfere with use of the tank. It is planned that a small hoist and handling equipment be installed shortly to improve the handling procedure for the cover as well as for any heavier items to be tested. (An improved handling system has been installed since this review was written.)

The pressure vessel is available for use on-site for a charge which is dependent on the requirements for assistance, measuring instruments, etc.

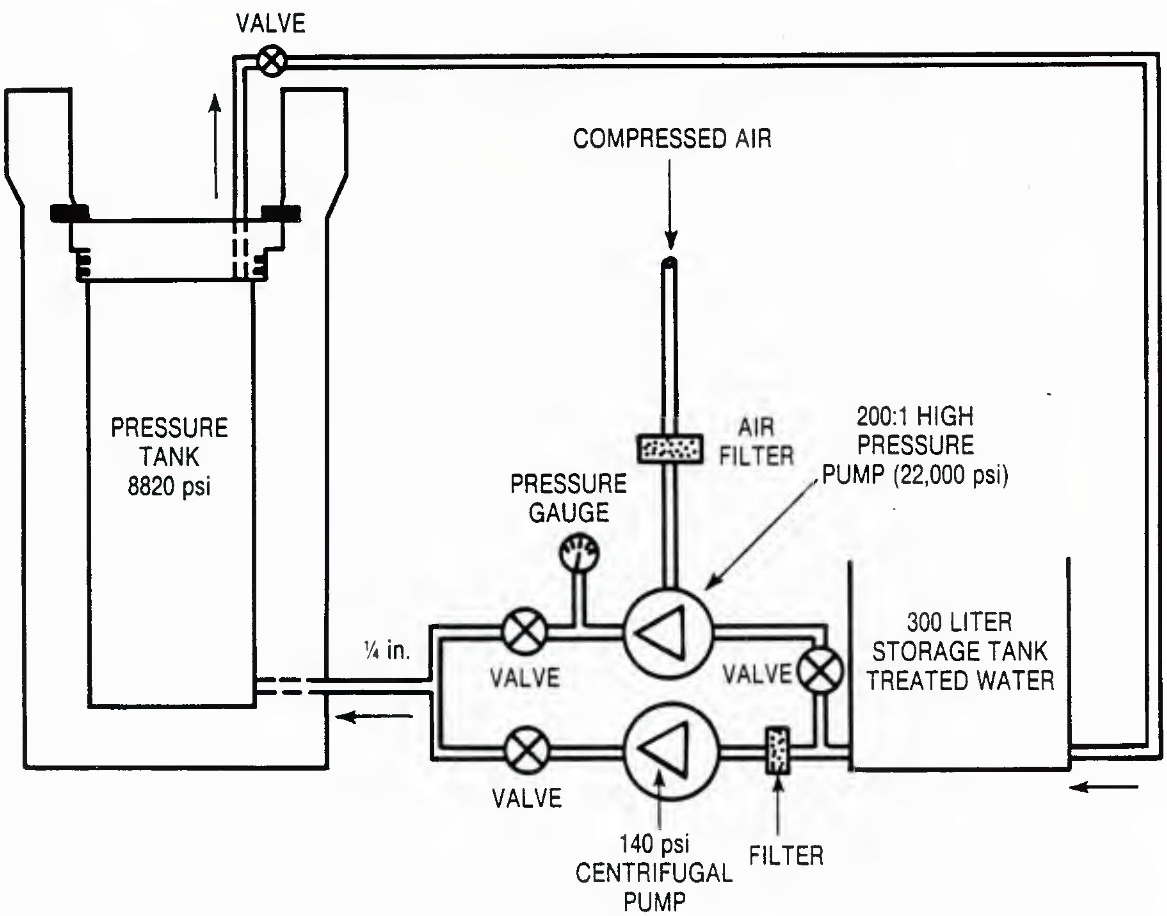


Figure 2-7. Filling and Pressurization Process

Date of this Summary
6 May 1985

Facility Name: Transducer Calibration and Test Tank

Location: Reson System ApS., Hilleroed, Denmark

Cognizant Organization: Reson System ApS.

Facility Functional Name: Calibration Tank

Major User(s): Reson System ApS., oil/gas companies, other contractors

Technical Areas Supported: Transducer development

Special Programs Supported: High frequency side-scan sonar developments

Unique Features: Totally anechoic at 30 kHz and above. At 10 kHz, first reflection is 12 dB down. Daily reciprocity calibrations made on four or five reference elements. All data from tank measurements digitally processed on IBM PC.

Significant Equipment Available: IBM PC digital computer with extended 512K RAM; and all IBM-compatible peripheral equipment including a Reson System-built digital computer with a 6809 microprocessor and two disc drives, keyboard, RGB Vision III color display, monochrome data monitor, and an X-Y plotter for hard copy.

Local Environment: Rural, very quiet.

Future Plans for Facility: Completion of the motor driven support trolleys and rotating shaft system. Installation of an improved Fortran CPU in conjunction with the IBM PC is expected to speed up computations of beam patterns and near-field/far-field corrections by a factor of 100. Completion and implementation of a scanning system for near-field measurements (phase and amplitude) required for measurements of narrow beam widths for side-scan sonar elements. (Since the time of this review, the automated computerized calibration/test system has been fully implemented. Individual tests can be quickly and easily programmed. All measurements are performed automatically and hard copy results are automatically produced. Automatic measurements include beam patterns, impedance plots (Z, R, and X), transmit and receive responses, and multi-transducer (up to 8) reciprocity calibrations.)

Facility Mailing Address: Reson System ApS.
4 Attemosevej
DK-3400 Hilleroed
Denmark

Local Contacts: Mr. Per Resen Steenstrup, Technical Manager
At the above address
Tel: Int. Oper. + 45 + 2-265240

Contact for Access/Scheduling: Requests for use and scheduling of the calibration tank should be through Mr. Per Steenstrup at the above address.

Narrative Description: The transducer calibration and test tank at Hilleroed is normally used from 10 kHz to 2 MHz but could be used at frequencies as low as 3-5 kHz. The tank is constructed of beechwood and is lined with fiberglass, inside and out. The inside of the tank is totally covered with Fafnir-type wedges, extending 11.8 in./30 cm. into the tank. The wedges in this tank, made of pressure-impregnated beechwood, are equivalent to $\lambda/2$ at 2.5 kHz in length. The open surface of the water is also covered with wedges extending 11.8 in./30 cm. downwards from floating panels. The free volume of the tank not occupied by wedges is 9.8 x 6.6 x 4.9 ft./3 x 2 x 1.5 m.

Currently the support trolleys for the rotatable shafts are temporary installations, fixed in position. They are to be replaced during the summer and fall of 1985 with permanent motor-driven trolleys. The shafts and trolleys will support a maximum weight of 220 lb./100 kg. With the permanent installation, the shafts will be movable under motor drive in both the X and Y directions. They will both be rotatable, both will be capable of raising or lowering, and one shaft will be tiltable to ±45° in the direction of the long dimension of the tank.

The measurement arrangement including the instrumentation is sketched in Figure 2-8.

Additional Comments: The digital transient recorder (manufactured by rene maurer) and the Reson System-built power supplies stepper motor, control panel, and the panel containing the automatic variable inductance/variable attenuator circuits as well as the pulse shaper and gating circuits are all mounted in a short relay rack adjacent to the tank with the synthesizer oscillator and oscilloscope mounted on top. The rack is supplied with a thermostatically controlled heater circuit which is activated whenever the rack is not in use.

The balance of the equipment, the Reson System-built digital computer with dual disc drives, the Graphtek X-Y plotter, the Taxan color-graphic monitor, the Taxan data monitor, and the keyboard are all table-mounted in a raised area with a view of the measurement in process in the tank.

At the conclusion of the measurement, the data recorded on the two discs are removed from the Reson System-built computer and taken into another building for data processing and analysis on the IBM PC.

The company philosophy is to design the tank as mechanically simple as possible, to be operated by one man, and retaining only the complexity necessary to meet the needs of Reson System ApS.

Information supplied in the report will depend on the information requested, but normally will include transmitting responses and/or receiving sensitivities, beam patterns at critical frequencies and impedance plots.

Since the tank is available to other users on a "service basis," a questionnaire form, duplicated here and shown as Figures 2-9(a) and 2-9(b), has been prepared on which the customer can make his request and which leads the customer through the forest of terms that may be unfamiliar to him.

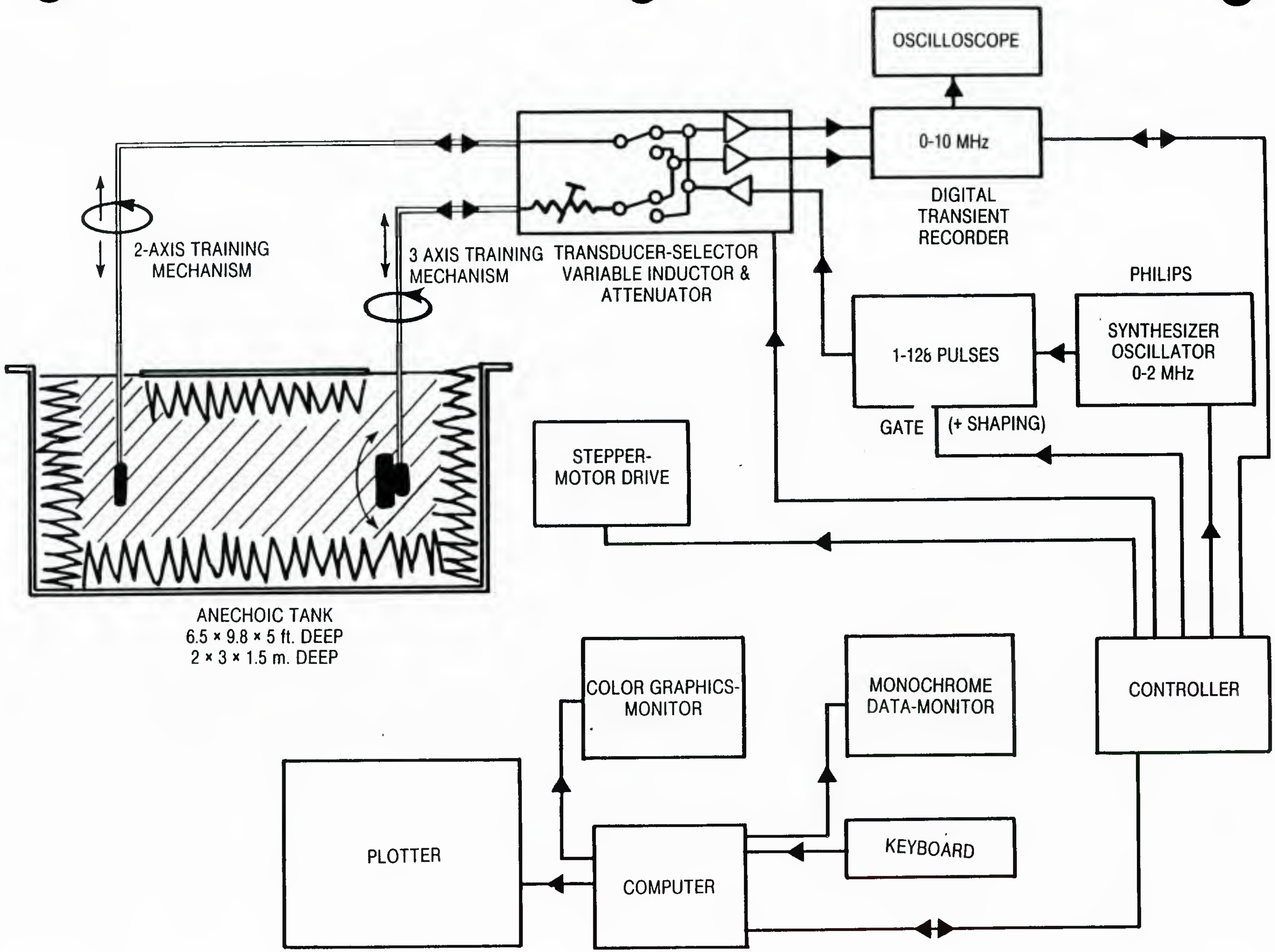


Figure 2-8. Measurement Arrangement, including Instrumentation

TD 7903-1

DIRECTIONAL TRANSDUCERS

Questionnaire

Company Name: ______________________ Country: ____________

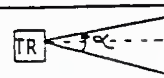
Address: ______________________ Telex no: ____________

Telephone Number: ______________________

Person to Contact: ______________________

Acoustical Characteristics

1. Operating frequency or frequency band (kHz): ____________

2a. Directivity pattern: Conical? ☐ Yes ☐ No 

2b. If conical directivity pattern, please indicate approximate opening angle at -20 dB or -3 dB: ____________

2c. Other shapes, please explain by means of a sketch. Sketch attached: ☐

3. Should the directivity pattern be controlled by means of electronics? (Sonar transducers)

   ☐ Yes ☐ No

   If yes, please indicate through which angles the beam should be swept: ____________

   ____

4. If the transducer is going to be used for sonar or echo sounding applications, please indicate the maximum required range (feet, meter): ____________

5. Is low ringing essential? ☐ Yes ☐ No

Electrical Characteristics

6. At what maximum power level will the transducer be operated?
   (Watts)? ____________ or (Source level)? ____________

7. Required input impedance at operating frequency (ohms): ____________

8. Two or three lead electrical input? ☐ Two ☐ Three

9. Is a bias voltage applied? ☐ Yes ☐ No

Physical Dimensions

10. How is the transducer going to be mounted? ____________

    ____

    ____

Figure 2-9(a). Reson System ApS. Questionnaire, Page 1

Physical Dimensions (Continued)

11. What are the housing dimensions? ______________________________
    If possible, please attach a sketch. ☐ :Sketch attached

12. What is the largest acceptable electric cable diameter?
    (millimeters, inches): ______________________________

13. Where should the cable outlet be to match the housing? Preferably it should be on the center axis. If not, please indicate on a sketch.
    ☐ :Sketch attached

Physical Environment

14. Maximum depth of operation (feet, meters): ______________________________

15. Within what temperature range will the transducer be handled and operated,
    °C or °F: ______________________________

16. Will the transducer be operated in other liquids than seawater? (If yes, what liquids?)
    ____
    ____

17. In what geographic spots of the world will the transducer be used?
    ☐ Artic Zone ☐ Tropical Zone ☐ Temperate Zone

18. Is the transducer going to be used in a new system? ☐
    Or an existing system? ☐

19. Other comments: ______________________________
    ____
    ____
    ____
    ____
    ____
    ____
    ____
    ____

Figure 2-9(b). Reson System ApS. Questionnaire, Page 2

Date of this Summary
20 May 1985

Facility Name: Brüel & Kjaer Laboratories

Location: Brüel & Kjaer Manufacturing Plant, Naerum Hovedgade, Naerum, Denmark 10 mi./16 km. north of Copenhagen)

Cognizant Organization: Brüel & Kjaer A/S

Facility Functional Name: Brüel & Kjaer central research facilities

Major User(s): Brüel & Kjaer development and production groups

Technical Areas Supported: Brüel & Kjaer product development and production control

Unique Features: Complete facilities for development and manufacture of hydrophones, microphones, accelerometers and all associated circuitry

Significant Equipment Available: Calibration tank (13.2 ft. long x 9.9 ft. wide x 6.6 ft. deep/4 m. long x 3 m. wide x 2 m. deep); thick film facility; facilities for multiple vulcanization of chloroprene-jacketed hydrophones or connectors

Local Environment: The Brüel & Kjaer plant is in an acoustically quiet area in Naerum, which is approximately 10 mi./16 km. north of Copenhagen.

Future Plans for Facility: To construct a new tank facility to be used specifically for R&D purposes.

Facility Mailing Address: Brüel & Kjaer A/S
Naerum Hovedgade 18
DK-2850 Naerum
Denmark

Local Contacts: Mr. Ole V. Olesen
At above address
Tel: Int. Oper. + 45 2 80 05 00

Contact for Access/Scheduling: Mr. Ole V. Olesen (as above)

Narrative Description: Brüel & Kjaer has been a well known name worldwide in the field of underwater acoustics since the late 1940's with the durable One-Third Octave Filter Analyzer and the associated Graphic Level Recorder.

The company employs a staff of approximately 2200 people and is located just north of Copenhagen, in Naerum, Denmark. It has also its own offices in 20 countries and is represented in 55 other countries. 98% of its production is for export.

Brüel & Kjaer was founded in 1942 and (at the time of writing) plant production is still under the direction of Viggo Kjaer, while Per V. Brüel continues to direct the world-wide sales operation.

Narrative Description (Cont'd):

While Brüel & Kjaer produces a wide variety of measurement instruments used in underwater acoustics, they produce only the four well-known hydrophones in the 8100 series shown below in Figure 2-10.

Three of the four hydrophones shown can be found in almost every underwater acoustic facility in Europe, as well as many other facilities throughout the world, and are the standards, or reference, hydrophones for most such facilities. The fourth hydrophone, the 8105, is a new (at the time of writing) spherical hydrophone.

The 8104 has a 32.8 ft./10 m. cable with a BNC plug at the end. The hydrophone has a receiving sensitivity of -205 dB re 1 V/µPa and flat response from 1 Hz to 40 kHz. It is usable to a frequency of 120 kHz. There is no preamplifier so it is a reciprocal element which lends itself to reciprocity calibration techniques (i.e., it can be used as both source and receiver). As a consequence, it is found throughout Europe and much of the rest of the world as a calibration standard.

The Type 8103 hydrophone is a small transducer (similar in size to the LC-10) with a total length of 1.97 in./50 mm. This element is also a reciprocal unit, used over the frequency range from 0.1 Hz to 180 kHz and has a receiving sensitivity of -211 dB re 1 V/µPa over most of the band. It is supplied with 19.7 ft./6 m. of tri-axial cable and a non-waterproof connector.

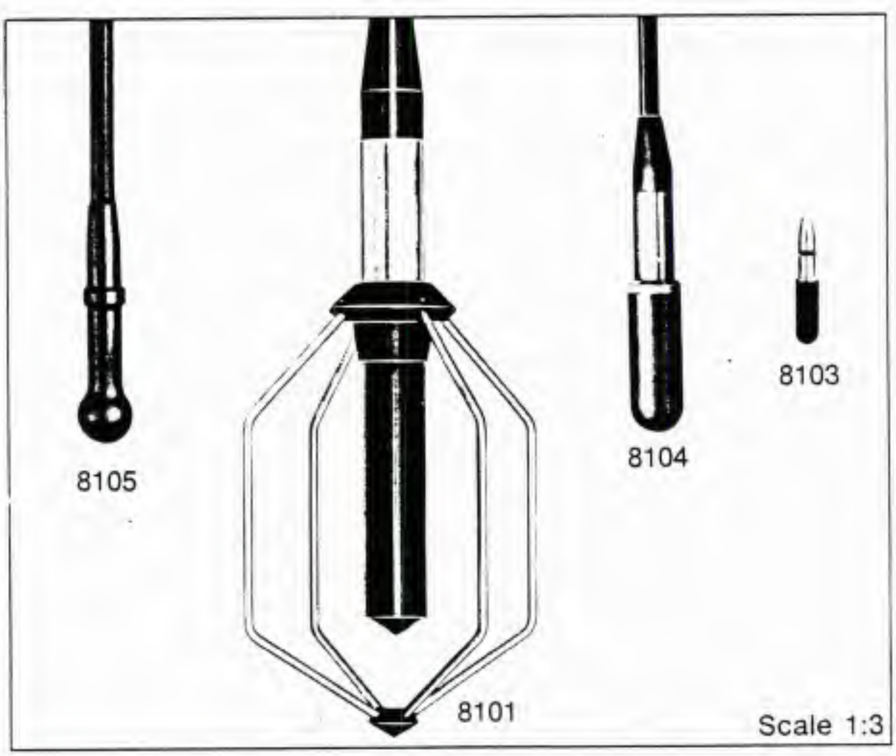


Figure 2-10. Brüel & Kjaer Hydrophone Configurations

Narrative Description (Cont'd):

The Type 8101 is a receiving-only hydrophone with a sensitivity of -184 dB re 1 V/µPa essentially flat from 1 Hz to 40 kHz but usable to 125 Hz or higher. It is provided with an internal solid-state preamplifier (12-24 Vdc) and an external protective cage. The total length of the unit is 9.76 in./248 mm. including the protective cage, and has a diameter, again including the cage, of 5.21 in./132 mm. This unit is used extensively as the receiving hydrophone for ship radiated noise measurements in noise ranges. The hydrophone includes an internal 50 ohm calibration resistor. The exposed parts of the element are chloroprene and cupro-nickel. The unit is supplied with 32.8 ft./10 m. of water-blocked cable terminated on a Brüel & Kjaer 7-pin plug.

Type 8105 is a spherical hydrophone with a sensitivity of -205 dB re 1 V/µPa, with a flat response from 0.1 Hz to 100 kHz and usable up to a frequency of 160 kHz. There is no preamplifier so that it is a reciprocal element and can be used both as source and transmitter. The 8105 is completely omnidirectional in the X-Y plane and over 270° in the X-Z plane, over the entire frequency range. It is fitted with 32.8 ft./10 m. of water-blocked cable terminated with a BNC plug.

Extension cables and user-assembled waterproof connectors are available for use with the Types 8101/4/5.

One feature which makes the Brüel & Kjaer hydrophone series attractive is the availability of the calibration unit shown in Figure 2-11.

The battery-operated calibrator (Type 4223) provides a rapid and relatively easy method of calibrating all of the Brüel & Kjaer hydrophones in air, in the field. The unit is essentially an air pistonphone which operates at 250 Hz.

Each of the four Brüel & Kjaer hydrophone sizes is provided with its own adapter or coupler for use with the calibrator. Figure 2-12 shows the method of coupling each hydrophone to the calibrator.

Brüel & Kjaer sells approximately 800 hydrophones per year and each of these hydrophones is checked at 250 Hz with a calibrator and each is calibrated in the calibration tank from 5 kHz to 200 kHz using pulsed sine waves.

Figure 2-13 is a photograph of the calibration tank at the Brüel & Kjaer facility and Figure 2-14 is a diagram of the associated electronics.

As noted previously, the calibration tank dimensions are 13.2 ft. long x 9.9 ft. wide x 6.6 ft. deep (4 m. long x 3 m. wide x 2 m. deep). Measurements are normally made at mid-depth (about 36 in./90 cm. above the bottom).

Occasional reciprocity checks on their own standards are made in this tank with three units mounted in an equilateral triangle having 24 in./60 cm. on a side.

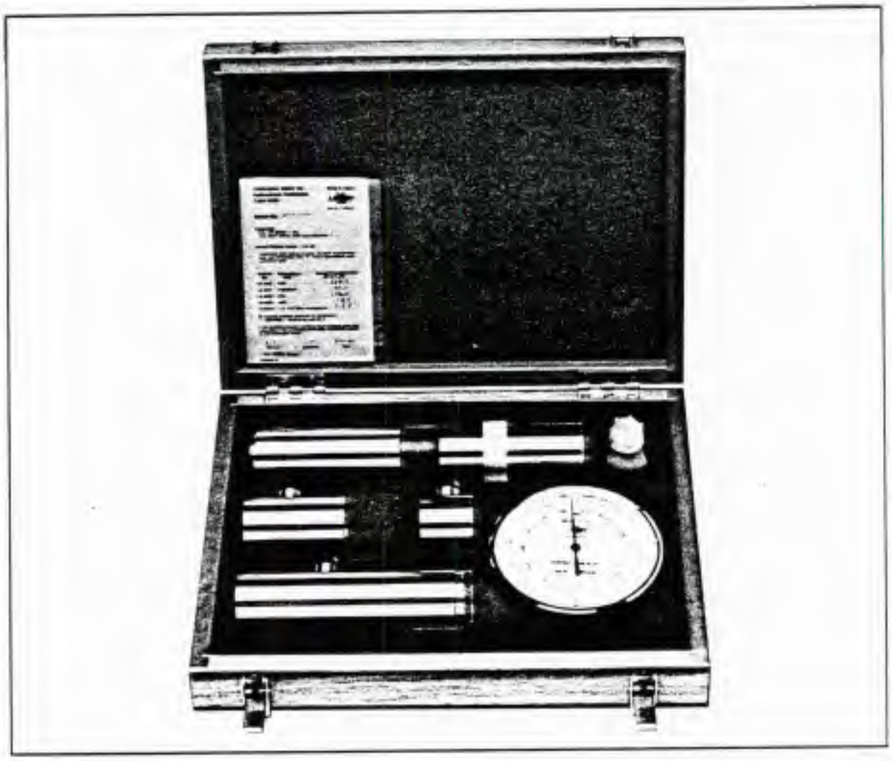


Figure 2-11. B&K Hydrophone Calibrator

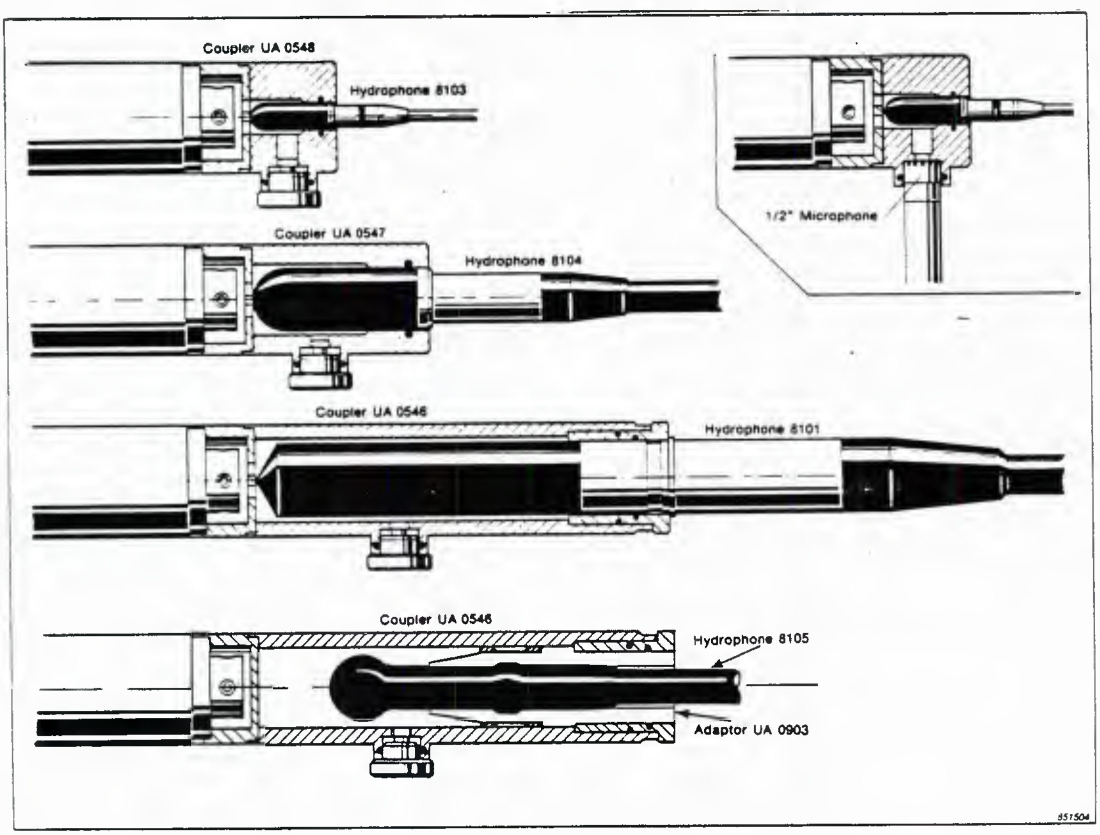


Figure 2-12. B&K Hydrophone to Calibrator Couplers

Figure 2-13. B&K Calibration Tank

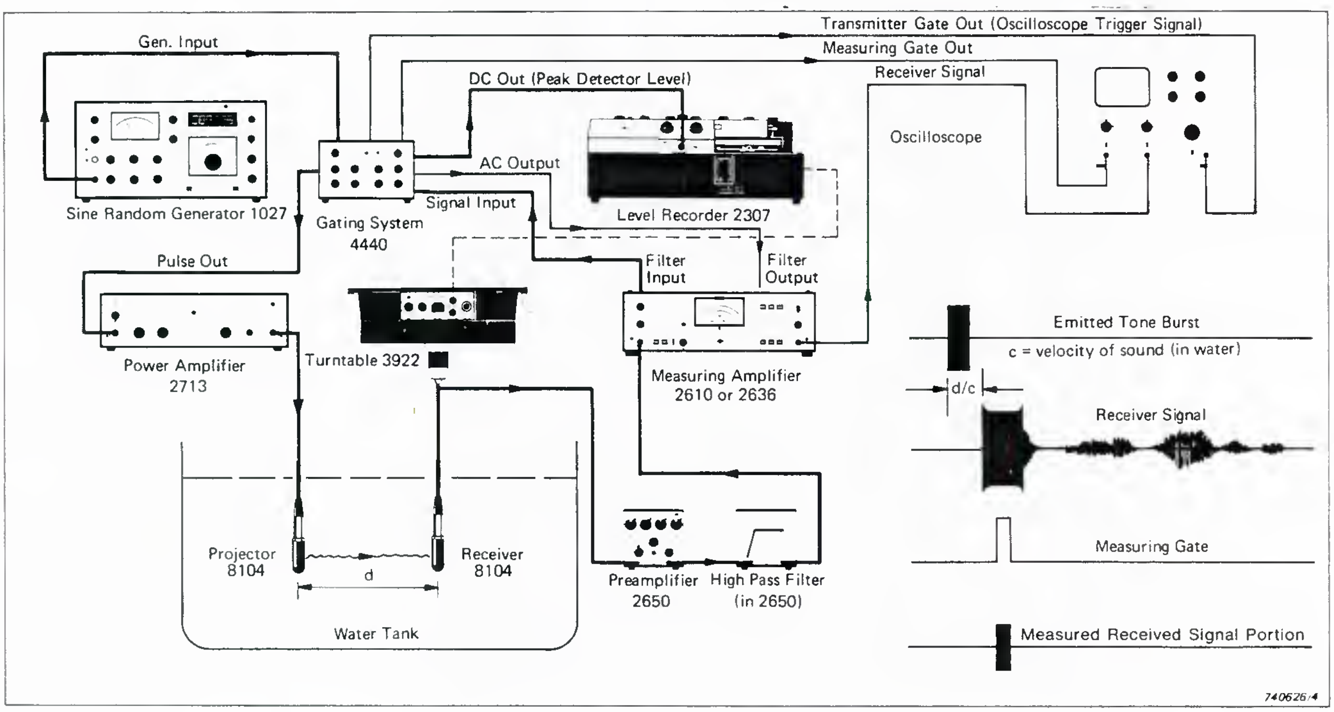


Figure 2-14. B&K Calibration Electronics

Date of this Summary
15 May 1985

Facility Name: Danish Hydraulic Institute, Offshore Division

Location: Hørsholm, Denmark, about 16 mi./25 km. north of Copenhagen

Cognizant Organization: Danish Academy of Technical Services

Facility Functional Name: Hydraulic Institute

Major User(s): Varied. Offshore oil and gas companies, Danish government, many foreign governments, US Army Corps of Engineers, fisheries, harbor development, shipbuilders, and shipping companies

Technical Areas Supported: Coastal rivers and harbor protection, bathymetric surveys, and offshore construction

Unique Features: A large 3-dimensional wave basin for open ocean simulation and four model basins for shallow water (harbor) simulations. All basins are provided with wave generating and current generating capability.

Significant Equipment Available: Seismic profiling system, side scan sonars, depth recorders, wave gauges, current meters, temperature, salinity and conductivity sensors, as well as meteorological recording units. Data processing equipment including computers, A/D conversion systems, recorders, printers and plotters.

Local Environment: Quiet area in Hørsholm which is a suburb of Copenhagen, approximately 16 mi./25 km. north of the city.

Future Plans for Facility: None specified.

Facility Mailing Address: Danish Hydraulic Institute
Agern Alle 5
DK-2970 Hørsholm
Copenhagen, Denmark

Local Contacts: Mr. Peter Hinstrup, Head, Offshore Division
Mr. Hugo Meister (Chief Engineer)
Tel: Int. Oper. + 45 + 2 86 80 33

Contact for Access/Scheduling: Mr. Hinstrup or Mr. Meister (as above)

Narrative Description: Although the Danish Hydraulic Institute (DHI) is not engaged directly in the study of underwater acoustics, they do use a number of underwater acoustic tools. Certainly the in-house deep wave-basins are very suitable for some acoustic measurements and are in fact so used to calibrate in-house acoustic sensors and have been used by the University and by industrial groups (e.g., Reson System ApS.), especially for (high frequency) array studies where relatively large separations are required. Much of the Institute's field equipment is either acoustic in nature or consists of oceanographic or navigational devices commonly used in support of acoustic programs.

Narrative Description (Cont'd):

The staff of the Danish Hydraulic Institute numbers approximately 150, of whom half are university graduates holding M.Sc. or Ph.D. degrees.

Institute policy is governed by a board of ten members, appointed by the Danish Academy of Technical Sciences representing government, science, and industry.

The organization of the DHI is shown below in Figure 2-15.

Additional Comments: DHI is an independent non-profit engineering/consulting organization established in 1964 by the Danish Academy of Technical Sciences in cooperation with the Technical University of Denmark. DHI is a member of a family of research institutes (with more than 1300 employees covering a wide range of technical subjects) and participates in joint ventures with other members when appropriate.

DHI conducts an independent program of applied research financed by funds derived from consulting work and by Danish Government grants. More than half of the work by the Institute is for clients abroad with projects in more than 50 countries.

The scope of work performed by DHI is outlined in Table 2-1.

Much of the work indicated in Table 2-1 is accomplished in-house, utilizing the facilities of the Hydraulic Laboratories such as the model basins for coastal harbor studies and the deeper three dimensional wave basin for offshore studies.

Some of the major facilities of the Hydraulics Laboratories are given in Table 2-2.

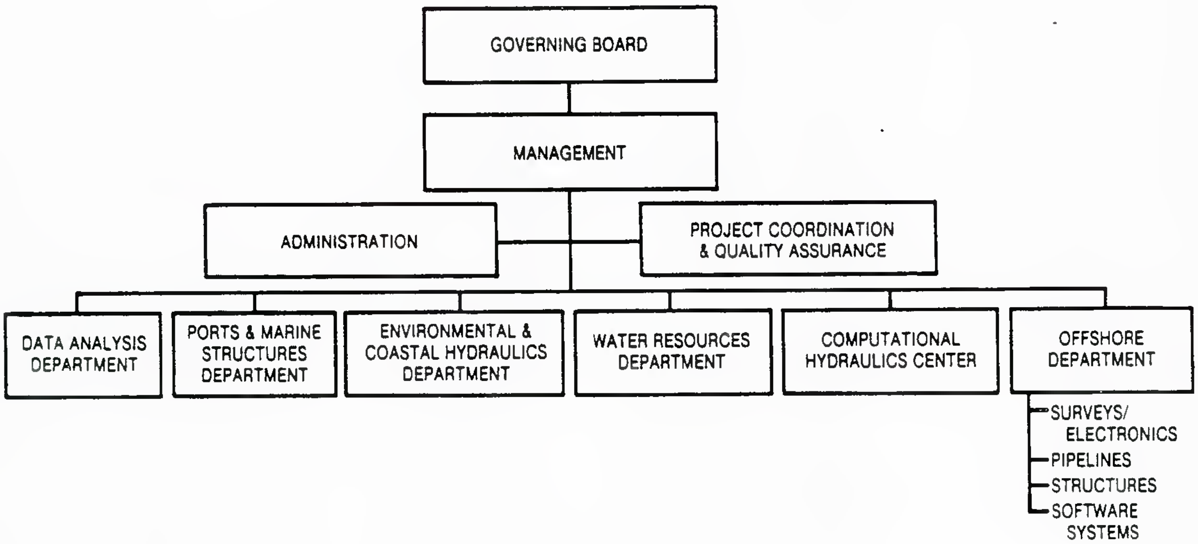


Figure 2-15. DHI Organization

Table 2-1. Scope of Work Performed by DHI

Coastal Structures
- Wave disturbance
- Ship motions
- Mooring line forces
- Breakwater stability
- Forces on structure
- Ship collision tests

Offshore Structures
- Environmental loads
- Riser model tests
- Tests of moored structures
- Pipeline consulting

Rivers
- Sediment transport
- Bank protection
- Dams and barrages
- Salt intrusion
- Discharge and stage computations

Hydrology
- Water resources development
- Irrigation and drainage
- Flood forecasting and control
- Urban hydrology
- Remote sensing

Sediment Transports
- Sedimentation and erosion
- Backfilling in dredged trenches
- Sedimentation in navigation channels
- Scour
- Beach development
- Coastal protection

Environmental Hydraulics
- Cooling water recirculation
- Transport and dispersion
- Sewage discharges
- Ocean outfalls
- Oil spill
- Optimization
- Water quality

Computational Hydraulics
- Hydrodynamic models
- Transport-dispersion models
- Tidal computations
- Storm surges
- Harbour resonance
- Wind wave hindcasts
- Storm sewer simulations
- River & channel flows
- Dam break studies
- Two-phase flows

Hydrodynamics
- Refraction, diffraction and reflection
- Wave theory
- Hydraulic transients
- Analysis and generation of directional sea

Field Surveys
- Hydrographic surveys
- Bathymetric and seismic surveys
- Offshore environmental monitoring
- Ice reconnaissance

Environmental Studies
- Design data evaluations
- Oceanographic studies
- Arctic investigations

Data Processing
- Statistical analysis
- Time series analysis
- Graphic presentation
- Data bank storage

Transfer of Technology
- Planning of hydraulic laboratories
- Hydraulic laboratory equipment
- Transfer of mathematical models
- Training programmes

Table 2-2. Major Facilities of the Hydraulics Laboratory

Model Basins
30 by 100 m. basin, maximum water depth 0.8 m.
37 by 25 m. basin, maximum water depth 0.9 m.
The latter basin is equipped with facilities for studies of cooling water and salt water discharges (hot water reservoir: 15,000 l. at 90°C, maximum hot water discharge: 20 l/s or 400,000 kcal/h, maximum input of saturated salt dissolution: 120 l/min).
25 by 16 m. basin, maximum water depth 0.8 m.
15 by 10 m. basin, maximum water depth 0.6 m.
All basins are equipped with pumps and movable irregular wave generators for easy change of wave directions in the models. Any combination of wave and current directions can be accomodated.

3-D Wave Basin
20 by 30 m. basin, water depth 4 m. (in pit: 12 m.).
For model testing in short-crested waves. The basin has 60 wave generators for generation of a three-dimensional wave field with wave of up to 0.7 m. The basin can accommodate scale models in shallow water (coastal structure) and in deep water (offshore structure).

Wave and Current Flumes
3.0 and 0.6 m. wide flumes with ventilators for representation of wind effects, maximum water depth 1.0 m.
All flumes are equipped with irregular wave patterns.

Irregular Wave Generators
DHI has pioneered the use of irregular waves in studies of wave disturbance in harbours and the introduction of moored model ships in such tests. Wave heights, ship movements and mooring, and fender forces are measured simultaneously.
All basins and flumes are equipped with movable irregular wave generators reproducing natural wave trains directly from site wave recordings. Wave generators and associated computing units have been developed by DHI.

Measuring and Recording Equipment
Automatic blend and temperature scanning system
Miniature propeller meters and electromagnetic flow meters
Photoequipment for flow pattern measurement
Resistance type wave gauges
Pressure cells for wave force measurements
Two-dimensional strain-gauge dynamometers
Displacement transducers and accelerometers
Photo-electric cameras for displacement measurements
Equipment for reproduction of fender and mooring stiffness and for simultaneous measurements of mooring and fender forces as well as ship movements
Multi-speed pen recorders
Multi-channel ultraviolet galvanometer recorders
Multi-channel wave height meters with rms measurements of the water surface displacement
Multi-channel data logging system

Model Ships
A range of model ships is readily available. New models can be supplied according to the client's drawings, usually within a few weeks.

Data Processing
Microcomputers are used in the models for data logging and online statistical analysis of up to 32 different signals from model tests. Further processing of recorded test data is performed on in-house PDP 11 and RC 3600 minicomputers and on an IBM 3033 installation using in-house terminals, printers, and plotters.

Additional Comments (Cont'd):

The dimensions of the concrete 3-D basin are given in Figure 2-16.

In Figure 2-17, which is a pictorial view of the 3-D basin, the movable bridge can be seen as well as some of the 60 wave generating paddles along the side (each paddle is 1.5 ft./0.5 m. wide and each is driven by a separate actuator).

Table 2-3 lists the field equipment and support systems available for at-sea measurements.

Not listed are the Furona Radar Systems (Japanese) routinely installed to scan an area of interest detecting and storing wave front directions.

Also not listed are the bottom corers: a small 2-4 in./5-10 cm. piston corer and a 5 in. to 6.6 ft., 660 lb. (10 cm. to 2 m., 300 kg.) drop corer. When these are not suitable a Vibra-Corer is obtained from a sister organization (Geotechnical Institute) for cores up to 16.5 to 19.8 ft./5 to 6 m.

The bottom and sub-bottom profilers are used primarily in conjunction with pipe laying or cable laying operations. The in-house profiler will yield a 3.3 ft./1 m. bottom penetration in the North Sea and 66 ft./20 m. in the Red Sea. Generally, DHI is satisfied with a 16.5-ft./5-m. penetration for their requirements. When in-house facilities are inadequate, EGG Boomers are rented from Danish or U.K. companies. (They do not use sparkers or air guns.)

An important element of most pipeline surveys is the determination of free spans. The equipment should operate without reducing survey speed and be carried by an ROV. This led to the development of the DHI Triple Head Sonar System, THSS. The THSS is an ROV-mounted free span detection device for use in a longitudinal pipeline survey. The system generates a continuous record showing the pipe seabed longitudinal profile highlighting possible free span sections.

One final system of interest, which DHI has produced, is a Trench Scanner installed on an underwater trenching vehicle for use in pipe or cable laying operations. The trench scanner is connected by tether cable to an HP 220 computer onboard the survey/support surface vessel and provides on-line hard-copy documentation of trench profiles and exact positioning and "sinking" of the cable/pipeline within the trench.

Figure 2-18(a) is an artist's sketch of the trench vehicle in operation. Figure 2-18(b) is a diagram of the scanner and Figure 2-18(c) is a sample of the scanner output data.

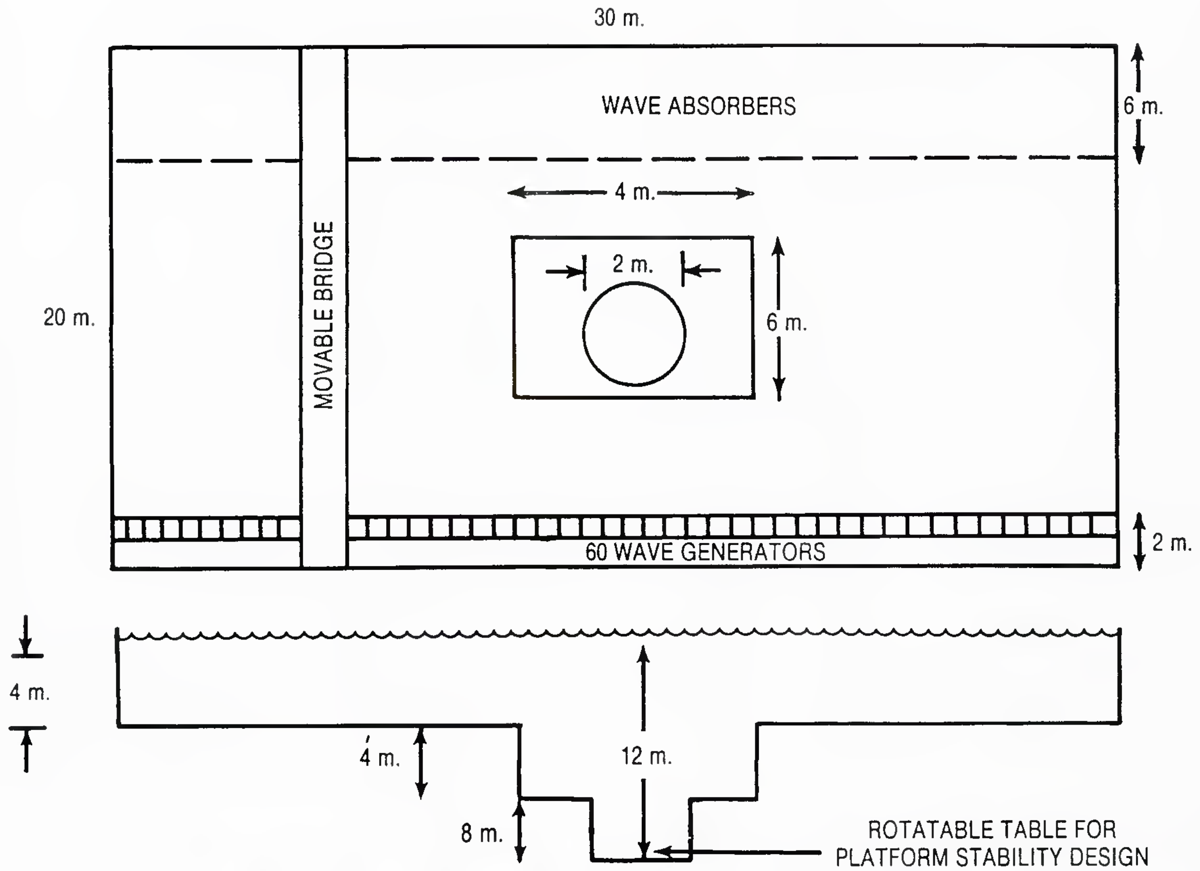


Figure 2-16. Sketch of Three-Dimensional Wave Basin

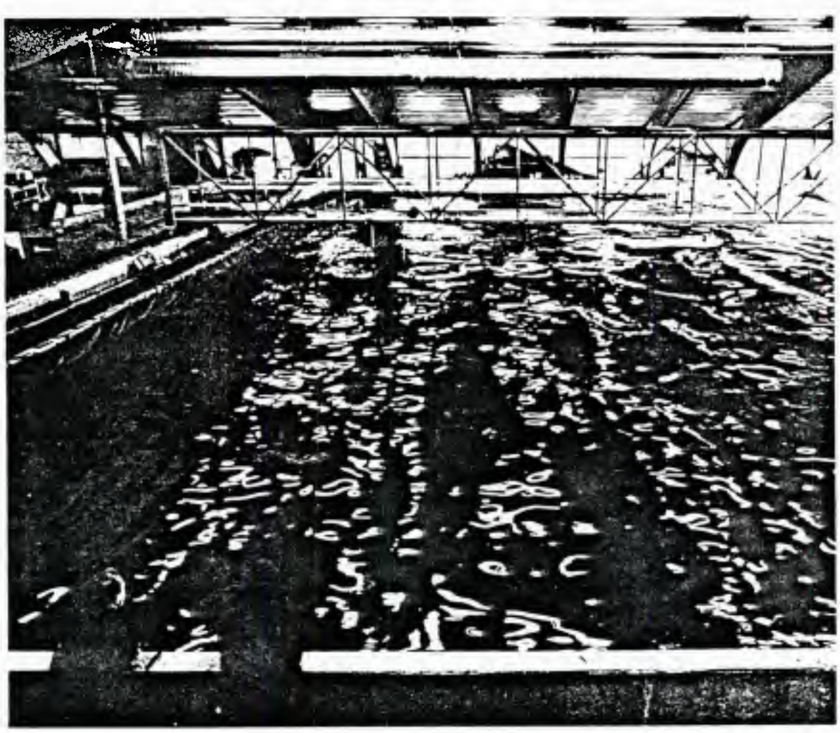


Figure 2-17. Three-Dimensional Wave Basin

Table 2-3. Field Equipment

Positioning Systems
Electronic positioning systems, type Motorola Mini-Ranger, with space diversity and tracking modes
Loran-C system with built-in computer
Omega navigation systems, type Sercel
Acoustic long-range positioning system, type Sea Link
Decca chain receiver, type Navigator
Laser ranging system, type Hydrodist

Computers: Motorola MRDP, HP 9845, HP 9836, HP 9825, HP 9826, video computers for black/white and colour monitors, Texas Silent 700 terminals with cassette decks.

Interfaces for Mini-Ranger, Trisponder, Syledis, Artemis, Argo, Pulse-8, Sea Link, Simrad HPR, Echosounder, Depth sensors, Temperature sensors etc.

Datalogging on standard cassette logger or digital IBM compatible tape stations.

Track and post plotting on high speed plotters, type HP 7580 or Houston Instruments DP plotters.

Software packed for navigation, surface survey, and R.O.V. survey, giving helmsman video display, datalogging, geographical coordinates, UTM and range-range with up to four reference and two positioning systems simultaneously. Post plotting facilities with survey quality assurance drawing and many other housekeeping and external facilities.

Sonar Systems
Side scan sonar, type EG&G
Seismic subbottom profiler 3.5/7 kHz/2 kW, type Raytheon 1000 modified by DHI
Seismic subbottom profiler 2.5/3.5/5/7 kHz/10 kW, type EDO Western for subtow
Seismic subbottom profiler 3.5 kHz/10 kW with separate hydrophone, type EDO Western for R.O.V. mounting
Digital dry paper recorders, type EPC
Tape stations for side scan and subbottom profilers, type HP/Racal and Tandberg
Iceberg draft profiler, type DHI/Helle Eng./Elac
Digital bottom-tracking echosounders 150 kHz, type DHI
Precision digital echosounder 30-210 kHz, type Navitronic
Echosounders 210 kHz, type Raytheon DE-719
Echosounders 30-50 kHz, type Honeywell-Elac
Acoustic release system (with 3 units), type Sea Link
Acoustic relocating systems, type Linda-Amlab

Wave Recorders
Radio transmission recorders, type Datawell Waverider, equipped with paper chart and/or cassette tape recording
Self-contained pressure cell recorders, with paper chart or cassette tape recording
Pressure cell gauges, type DHI, cable or radio transmission to shore, with cassette tape data logging

Current Meters
Propeller recorders (velocity and direction), type DHI-modified Aanderaa/Hydrowerkstätte, with tape recording
Propeller recorders, including temperature and conductivity recording
Rotor recorders (velocity, direction, temperature and conductivity), type Aanderaa
Electromagnetic self-recording current meters (velocity, direction and temperature), types EG & G
Current meters (x- & y-velocity components) with microprocessor, cassette tape recording, type Marsh McBirney
Current meters (x- & y-velocity components) cable to shore, type Marsh McBirney
Direct reading current meters (velocity, direction and, for some, temperature, depth and salinity), types Braystoke and DHI

Temperature and Salinity Meters
Self-contained temperature recorders, recording at 11 levels on magnetic tape, type Aanderaa
Direct reading temperature, conductivity, salinity and depth meters, type Inter Ocean, with printer or data logging facility, type DHI
Multi-channel direct reading precision temperature recorder with printer and cassette tape data logging, type DHI
Direct reading temperature, conductivity, salinity and depth with computer, winch, and 1000 m cable
Direct reading temperature and salinity meters, type Switchgear
Portable digital thermometer, DHI
Temperature scanner, 3 probes, DHI

Water Level Recorders
Tide recorders, paper chart, type OTT
Self-contained tide recorders, magnetic tape, type Aanderaa
Pressure cell tide recorders, cassette recording, type DHI

Wind Recorders
Wind recorders, paper chart, type Lambrecht
Wind recorder, direct reading, type Je-tex, equipped with DHI cassette data logger

Data Processing
The Data Processing Unit of DHI uses an in-house RC 3600 minicomputer for preprocessing of field data. Further processing is done on an IBM 3033 computer, using in-house printers, plotters and terminal connections.

Miscellaneous
Fluorometer, Impulsphysik
Instruments for land surveying
Calibration facilities
Instruments for suspended sediment sampling
Wash boring equipment and bottom samplers
Rubber boats and communication equipment
Buoys, moorings, timed and acoustic releasers, pingers etc.

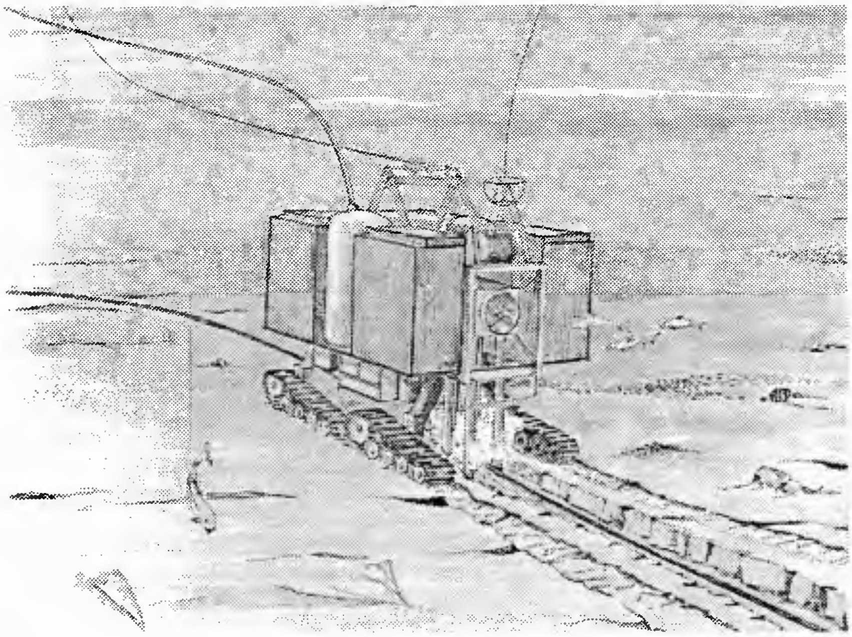


Figure 2-18(a). Trenching Vehicle

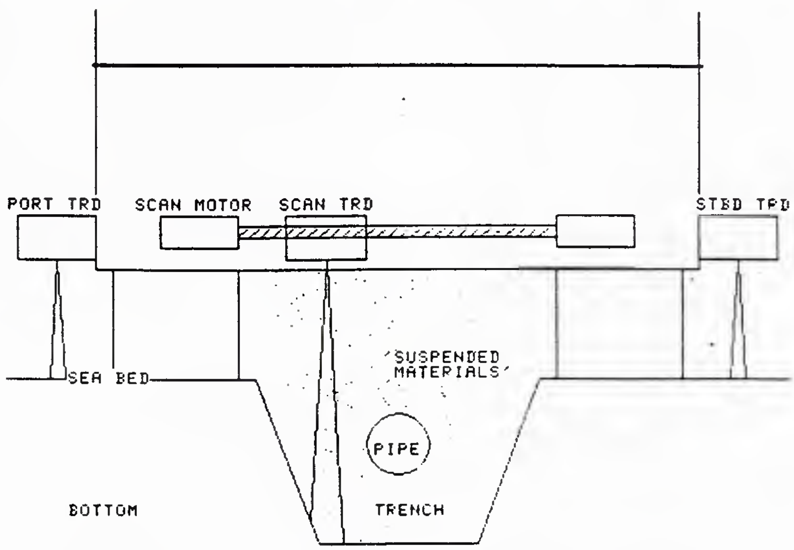


Figure 2-18(b). Diagram of Trench Scanner

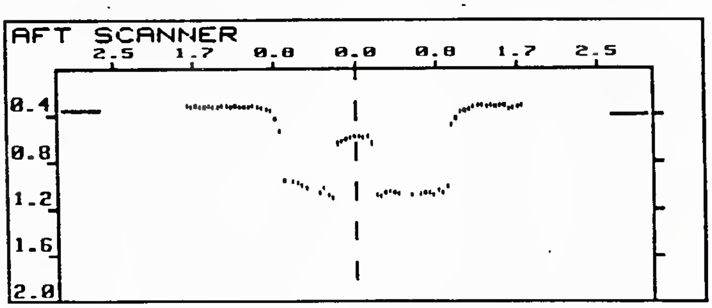


Figure 2-18(c). Sample of Scanner Output

Date of this Summary
21 May 1985

Facility Name: Danish Maritime Institute

Location: Lyngby (Copenhagen), Denmark

Cognizant Organization: Danish Academy of Technical Sciences

Facility Functional Name: Maritime Institute

Major User(s): Shipbuilders; ship operating companies; Danish and other Navies; fishery interests and off-shore oil/gas companies

Technical Areas Supported: Hydrodynamics, ship stability, ship maneuverability, propeller design, wind engineering (available energy, wind loads, aerodynamics, smoke dispersal), and in-ocean construction

Unique Features: Large towing tank with carriage, wave makers, planar motion mechanism, computerized data recording facilities, and shallow water (adjustable from zero to 3.3 ft./1 m.) maneuvering basin with carriage (from July 1986)

Significant Equipment Available: Three model testing basins, cavitation water tunnel, three wind tunnels, towed fish, model shops (ship models up to 32.8 ft./10 m.), and maneuvering simulator

Local Environment: Quiet area of Lyngby (a suburb of Copenhagen, approximately 6.25 mi./10 km. north of the city center.

Future Plans for Facility: Visual display with 3-dimensional perspective for the maneuvering simulator

Facility Mailing Address: Danish Maritime Institute
Hjortekaersveg 99
DK-2800 Lyngby
Copenhagen
Denmark

Local Contacts: Dr. G.S. Rodenhuis, Director
Mr. Leif Wagnersmit, Senior Naval Architect
At above address
Tel: Int. Oper. + 45 2 87 93 25

Contact for Access/Scheduling: Dr. G.S. Rodenhuis, at above address

Additional Comments: The Danish Maritime Institute (DMI), with a staff of 100, is located in Lyngby, approximately 6.25 mi./10 km. north of the center of Copenhagen. It is a non-profit affiliate of the Danish Academy of Technical Sciences and is 80% self-supporting through commercial programs. DMI is under the direction of Dr. Gaele S. Rodenhuis.

Additional Comments (Cont'd):

While none of the DMI programs or facilities are directly concerned with underwater acoustics, some do have acoustic ramifications or represent technical facilities that can be exploited for acoustic purposes. Such would certainly include the closed-cycle cavitation water tunnel used for propeller cavitation studies and the related propeller design program, towed fish design and test program, and the two towing tanks with towing carriage and wave generators.

The large towing tank, pictured in Figure 2-19, measures 787 x 39.4 x 17.7 ft./240 x 12 x 5.4 m. Model speeds of 19.4 kt./10 m/s. can be achieved in this tank. There are available 64 channels for data recording at the tank site, controlled by a DEC PDP 23. Data can then be transferred by hard wire to a larger Norsk Data Computer in the computer center. (In normal use, the data recorded includes such parameters as forces, angles, velocities, pressure, wave height, etc., but could as well record hydrophone outputs for flow noise or other acoustic sources.)

The 787 ft./240 m. length of the tank could make it very attractive for the measurement of high frequency acoustic arrays and for other acoustic studies requiring such longer ranges.

The ship models used in the large towing tank are constructed in the DMI model shop to a 30:1 scale. The models range in length from 3 to 32 ft./1 to 10 m. and can be fitted with "engines," screws, and fans for dynamic wind loading. A large amplitude PMM (Planar Motion Mechanism) is used for captive model testing in the horizontal plane and a second PMM tests captive models in the vertical plane.

The Cavitation Water Tunnel control station is shown in Figure 2-20 and Figure 2-21 is a picture of a propeller under test in the tunnel demonstrating strong tip vortex cavitation. The test section of the cavitation tunnel is 31.5 x 31.5 in./0.8 x 0.8 m. with a maximum water speed of 29.5 ft/s. (9 m/s.) or approximately 17.5 knots. A 95% vacuum is obtainable.

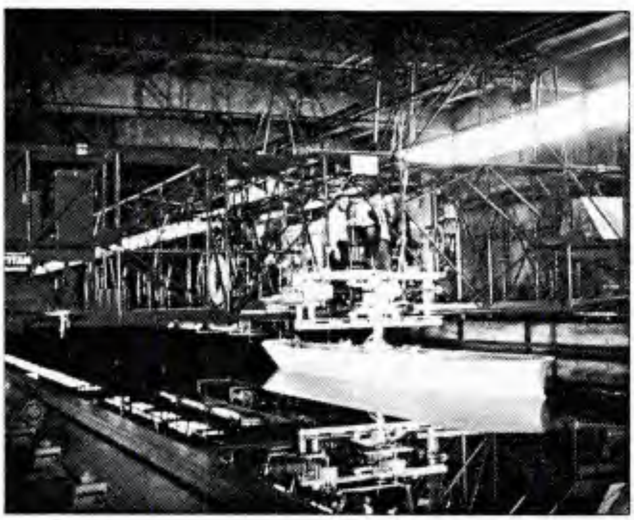


Figure 2-19. Large Towing Tank

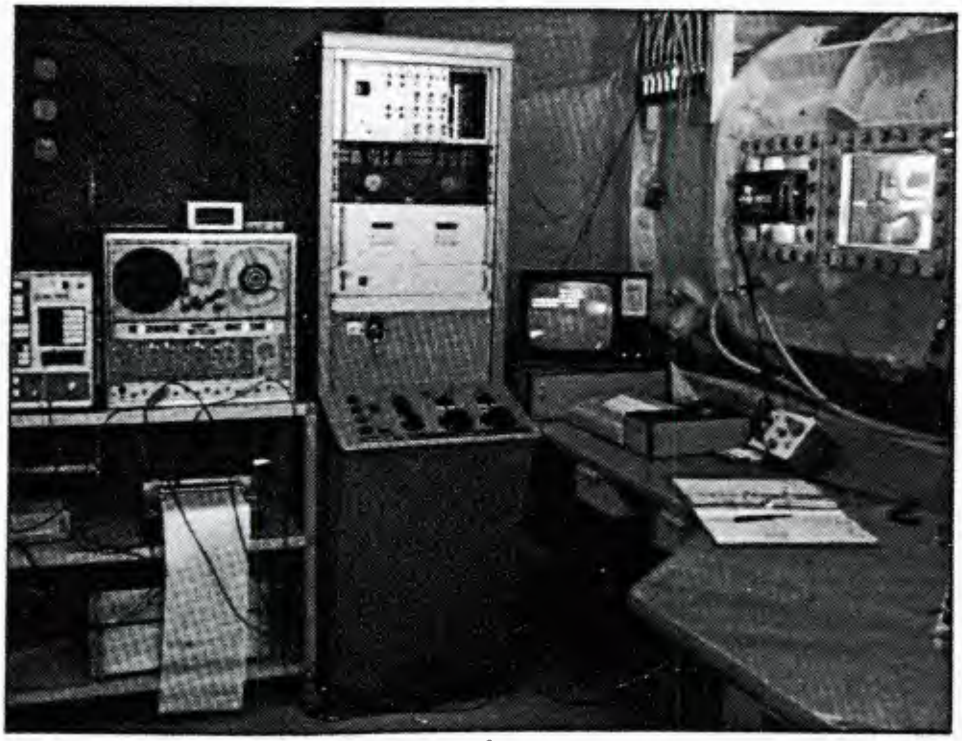


Figure 2-20. Cavitation Water Tunnel Control Station

Figure 2-21. Cavitation Propeller Under Test

Additional Comments (Cont'd):

Some details of the three wind tunnels and a listing of associated wind measurement equipment are given in Table 2-4.

The large wind tunnel is pictured in Figure 2-22.

DMI has a program of Towed Body design and testing. Such towed bodies are used for a variety of purposes, most of which involve acoustic systems of one sort or another.

A particularly successful example was one built for the Danish Institute for Fisheries and Marine Research in 1983. The towed body is of fiberglass reinforced plastic construction and is partly filled with polyurethane foam.

The length is 4.9 ft./1.5 m. and the weight is approximately 121 lb./55 kg. This unit has a slight positive buoyancy in water so that it will float if the tow cable is cut or broken.

The body is designed to tow at shallow depths from 6.6 to 26.2 ft./2 to 8 m. below the surface. The body can be caused to tow at the depth desired by adjusting the angle and wire length.

The tow body is roll-stabilized and tows stably at all speeds from 2 to 12 knots. It is towed from its bow and a bow hydrofoil is used to adjust depth and to cause the body to tow off to the side outside the bow wave of the towing vessel.

This particular unit is outfitted with a SIMRAD 38 kHz (38-29/25-E) echosounder transducer in the wide beam mode (8° fore and aft and 22° athwartships). Data are transmitted to the SIMRAD transceiver located on the towing ship through a shielded signal cable.

It is hoped that continued development in this area will result in improved tow bodies which can be towed at higher speeds at mid- or near-bottom depths and, provided with precision fathometers and/or side scan sonars, will be able to perform relatively high speed inspections of pipelines or cables on the sea bottom.

The DMI Tow Body with the bow hydrofoil can be seen in Figure 2-23.

One final facility of some general (non-acoustic) interest is the Ship Maneuvering Simulator, using a mathematical model of ship, harbor, and environment. The situation is presented in real time on a graphic screen which shows a bird's eye view of the harbor, the ships, tugs, land, and buoys as well as depth contours, winds, and currents. See Figures 2-24(a) and 2-24(b).

A visual display including 3 screens, each 6.6 ft./2 m. wide and 4.6 ft./1.4 m. high, providing a 3-dimensional perspective of the surroundings, is planned for installation in the beginning of 1987.

Table 2-4. Wind Measurement Equipment

Wind Engineering Facilities

Wind Tunnels	Dimensions of Working Section	Maximum Tunnel Speed	Field of Application
Tunnel no. 1 Open-circuit Boundary Layer	H = 1.14 m W = 1.14 m L = 10.0 m	12 m/s.	Wind Load Wind Environment Air Pollution
Tunnel no. 2 Closed-circuit Aeronautical	H = 0.70 m W = 1.00 m L = 2.60 m	80 m/s.	Wind Load Flow Visualization Aeronautics
Tunnel no. 3 Open-circuit Boundary Layer 3 turntables	H = 1.80 m W = 2.60 m L = 20.8 m adjustable height	24 m/s.	Static and dynamic Wind Load. Air Pollution. Wind Environment. Flow Visualization.

Measuring Equipment:

Wind forces. Wind force moments and Wind pressure. One six-component and one four-component balance for the measurement of total wind loads. One six-component piezo-electric balance for the determination of static as well as dynamic wind loads. Multi-channel pressure tranducer measuring system.

Wind velocity. Four-channel hot-wire measuring system. Wide range Traversing Mechanism.

Flow patterns and pollution concentrations. Visualization techniques. Photographing and videorecording. Smoke generators and tracer gas plants.

Computer equipment:

Nord-10 main computer. Test control, acquisition and analaysis of data with the aid of a PDP 11/23-computer. FFT analyzer.

Field measurement equipment:

Two mobile test stations for the determination of power performance of windmills. 16-channel telemetry system for straingauge measurements.

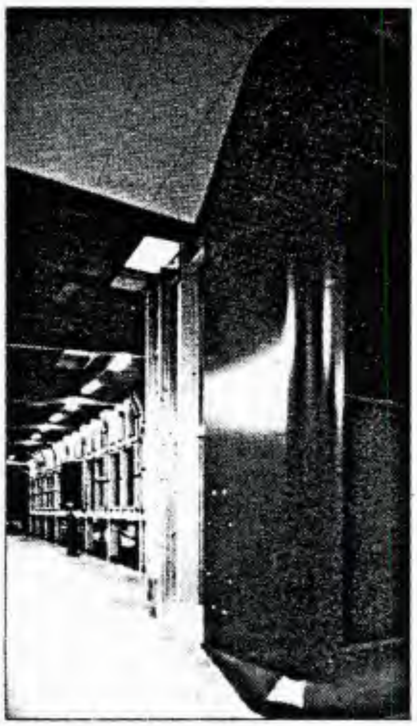


Figure 2-22. Large Wind Tunnel

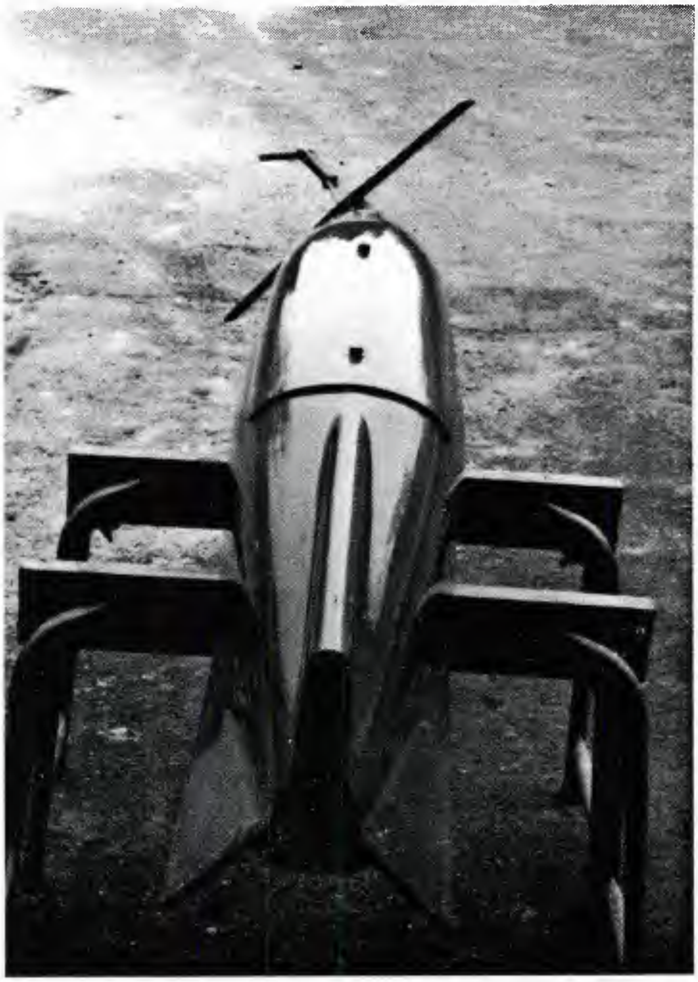


Figure 2-23. DMI Tow Body with Hydrofoil

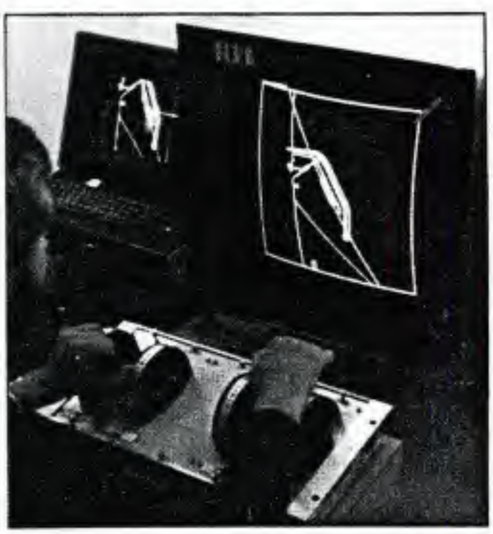


Figure 2-24(a). Operator at Controls of Maneuvering Simulator

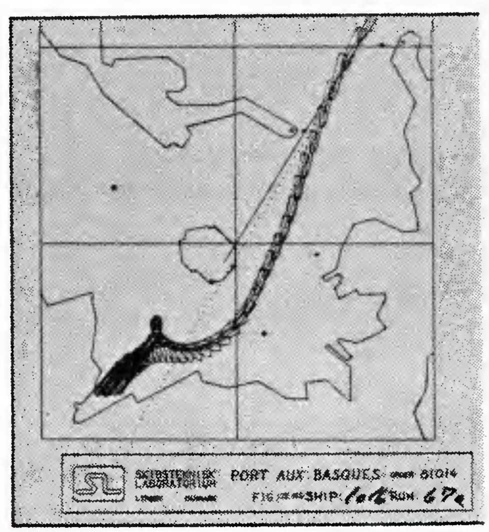


Figure 2-24(b). Ferry Track from Maneuvering Simulator

Date of this Summary
5 August 1985

Facility Name: Aamøy Noise Ranges

Location: The Measuring Station is 4.3 nmi./8 km. north northwest of Stavanger in southwest Norway on the Island of Aamøy. The ranges lie off the north side of the island.

Cognizant Organization: Norwegian Navy Materiel Command (NAVMATCOMNOR)

Facility Functional Name: Aamøy Measuring Station and Ranges

Major User(s): Norwegian Navy and other European navies; mainly submarines

Technical Areas Supported: Platform noise reduction

Significant Equipment Available: Bottom-mounted range hydrophones with integral preamplifiers; post amplifiers ashore in measuring station with one-third octave analyzers and display units; underwater telephone circuits to both ranges and hard-wire telephone circuit to the Static Range; level recorder, digital paper tape punch, and analog magnetic tape recorder.

Local Environment: It is a 15-minute boat ride from Stavanger to the Measuring station, a distance of 4.3 nmi./8 km., on the north side of Aamøy Island. Static Range is flat bottomed 131 ft./40 m. deep. Dynamic Range is in Mastra Fjord, 328-361 ft./100-110 m. deep. Boat traffic during daylight hours sometimes requires night operations. High currents at times.

Future Plans for Facility: Improved automation. Elimination of punched paper tape. Acquisition of digital computer with peripherals.

Facility Mailing Address:
Aamøy Maalestasjon
RSD
N-4020 Hundvaag
Stavanger
Norway

or

Norwegian Navy Materiel Command
N-5078 Haakonsvern
Bergen
Norway

Contact for Access/Scheduling:
Mr. Arnfinn Dyrøy
Ingeneer Sonar
Norwegian Navy Materiel Command
N-5078 Haakonsvern
Bergen
Norway
Tel: Int. Oper. + 47 5 32 2000

Narrative Description: The Aamøy Measuring Station is 4.3 nmi./8 km. north northwest of the city of Stavanger and is reached by boat from the Navy landing in the city. A 46-ft./14 m., 16-passenger Norwegian Navy boat services all Norwegian Navy-connected activities on the Island of Aamøy, including the Measuring Station and associated ranges. The boat trip takes approximately 15 minutes each way.

The Aamøy Noise Ranges are located off the north side of the Island of Aamøy. (See Figure 3-1.)

The Static Range is in a 131-ft./40-m. water depth over a flat sandy bottom approximately 0.53 nmi./0.98 km. northeast of the Measuring Station.

The Dynamic Range is in Mastra Fjord over a sloping mud and sand bottom which varies from 328 to 361 ft./100 to 110 m. in depth. The range is approximately 1.6 nmi./2.9 km. east northeast of the Measuring Station and lies between the Islands of Rennesoy and Mosteroy.

Tidal currents at these ranges are moderately severe. At the Dynamic Range, currents will reach 1 or 2 knots, while at the shallower Static Range, currents at times of particularly high tides will reach 4 or 5 knots.

Additional Comments: Twenty-six ferries transit the area each day which generate considerable acoustic interference, particularly at the Dynamic Range. At times there is significant interfering traffic noise from fishing vessels and recreational craft as well.

The ferries follow a regular schedule (posted in the Measuring Station) so that measurements can often be accomplished by working around the ferry schedule. If such cannot be managed, or if the unscheduled fishing or recreational craft interference is too great, then the measurements must be made at night.

At the Static Range, the two mooring buoys B3 and B4 (see Figure 3-1) are separated by 525 ft./160 m. and the receiving hydrophone is approximately 164 ft./ 50 m. south of the center of the line between B3 and B4.

The navigational chart which includes the Aamøy Range is:

Chart Number 16
Norges Sjøkartverk
Scale 1:50,000

Submarines normally run the Dynamic Range track at periscope depth but occasionally make the run fully submerged. Submarines can traverse the range at any speed desired.

Large surface ships (greater than 2000 tons/1786 British tons) are restricted to speeds no greater than 30 knots.

The Aamøy Range is used approximately 40 days per year. Measurements are made on perhaps 16 or 18 submarines each year and on 2 to 4 surface ships. The Static Range is used almost solely for submarines.

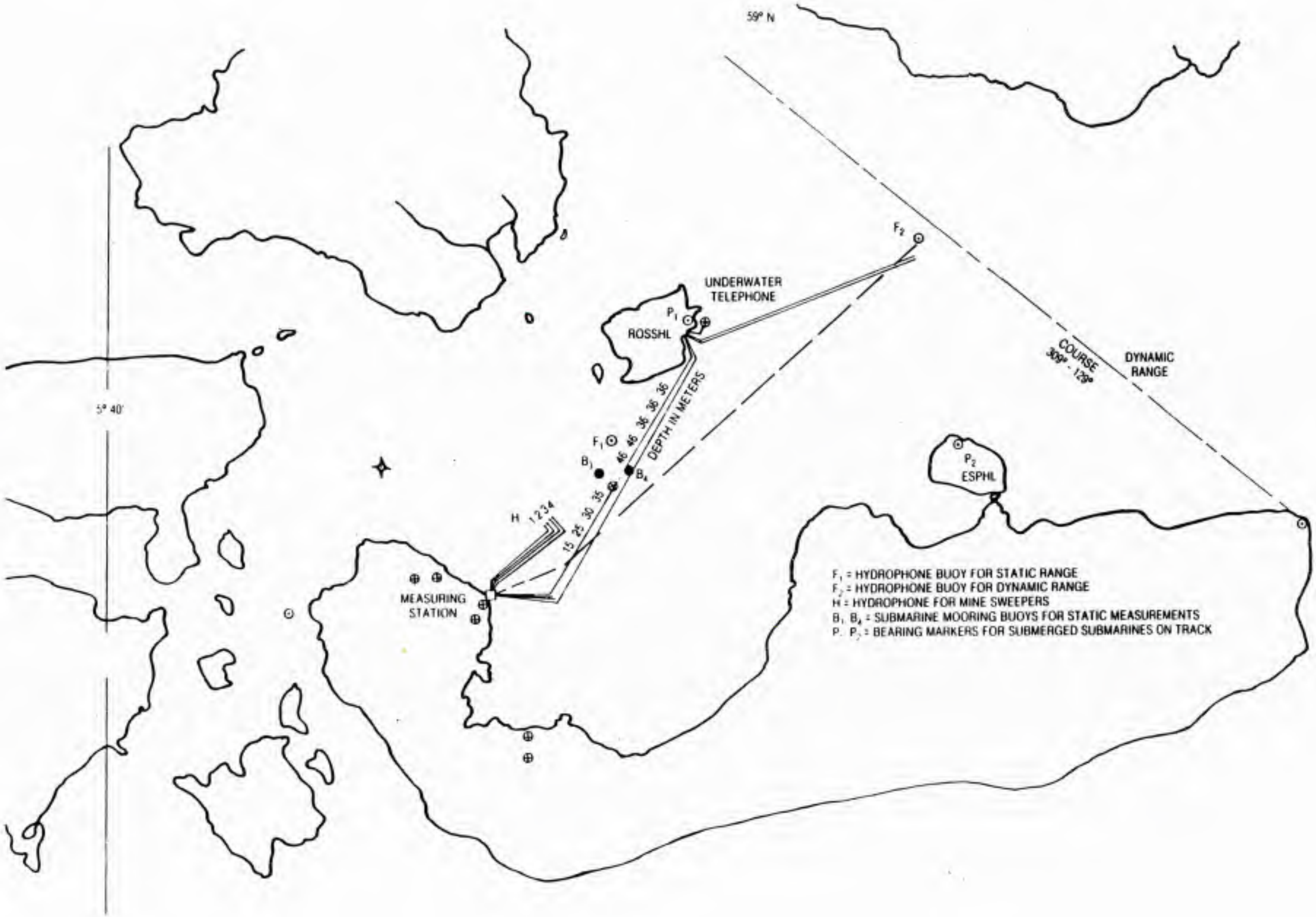


Figure 3-1. Aamøy Noise Ranges

Additional Comments (Cont'd):

As might be expected, the best times for measurements at the Range, in terms of weather, are during the spring and summer months.

The hydrophones for both the Static Range and the Dynamic Range are spherical ceramic elements 2.8 in./7.2 cm. in diameter, mounted approximately 27.5 in./ 70 cm. off the bottom as indicated diagrammatically in Figure 3-2. The hydrophone at the Static Range is 131 ft./40 m. deep and at the Dynamic Range the hydrophone is 358 ft./109 m. deep.

The entire assembly including concrete, anchor, hydrophone, preamplifier and support structure was fabricated by Ocean Research (Technology) A.S. of Bergen, Norway.

The preamplifier is a fixed gain 40 dB unit with a low impedance output driving 4920 ft./1500 m. of cable in the case of the Static Range and 13,120 ft./4000 m. in the case of the Dynamic Range.

Power to the preamplifier is supplied through a sea cable identified as Type AP13135 and the signals are brought ashore on a two-conductor shielded signal cable identified as Type 0.9EEZP.37D. The signal cable shield is tied to the preamplifier case internally and is grounded to the sea at that point through the preamplifier case.

The receiving sensitivity of the ceramic element alone (without the 40 dB preamplifier) is given in Figure 3-3.

The range of ambient noise spectrum levels from a quiet condition to a storm condition on the Aamøy Range is shown in Figure 3-4.

As noted earlier, there is an underwater telephone circuit between the Measuring Station and each of the two ranges; however, only the circuit to the Dynamic Range is normally used. A hard-wire telephone circuit into which the submarine on the Static Range can be connected is found to be much more satisfactory in view of the excessive reverberation on the underwater telephone in such shallow depths.

The measurement/recording system used at the Aamøy Measurement Station is shown in Figure 3-5.

For purposes of calibrating the instrumentation, the hydrophone is disconnected and the calibration signals are injected at the input to the HP Differential Amplifier.

The Brüel & Kjaer Level Recorder is run at slow speed throughout a ship/submarine test and is used for monitoring and as a log of events and times.

The Swiss-made NAGRA magnetic tape recorder has two analog direct-record channels plus one FM track for digital information and for camera synchronization where needed. Speeds available are 1-7/8, 3-3/4, 7-1/2, and 15 ips/4.8, 9.5, 19, and 38.1 cm/s. At Aamøy the recorder is generally run at 15 ips/38.1 cm/s. which provides a bandwidth of 20 Hz to 35 kHz on the direct-record channels.

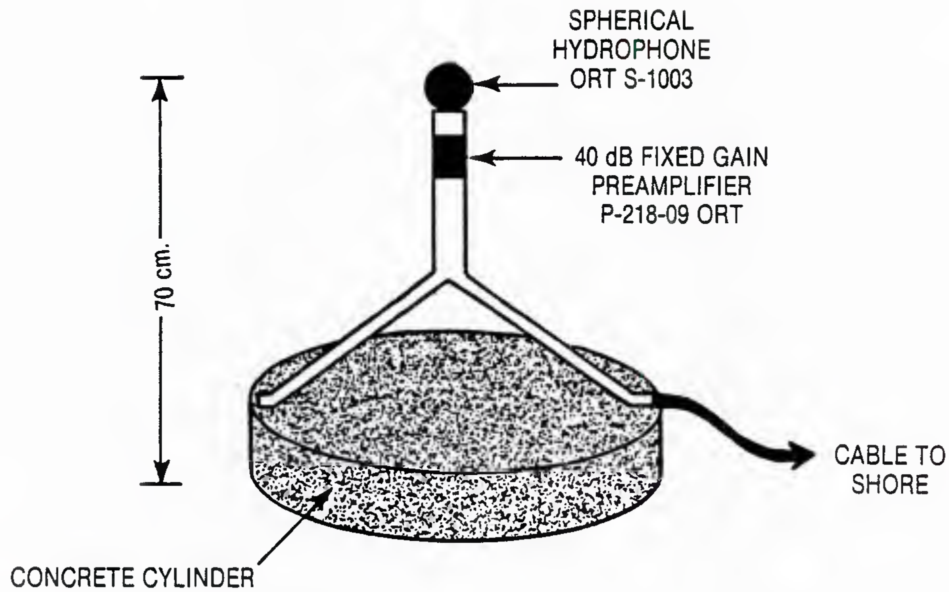


Figure 3-2. Aamøy Range Hydrophone

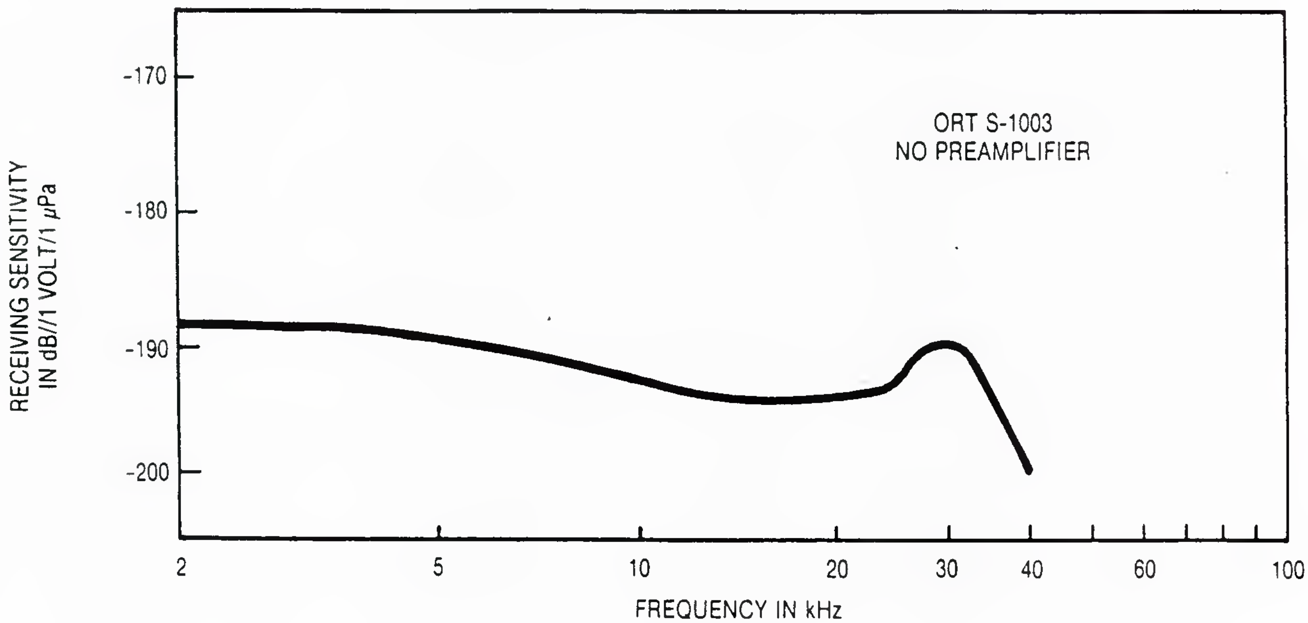


Figure 3-3. Receiving Sensitivity of Aamøy Range Hydrophone

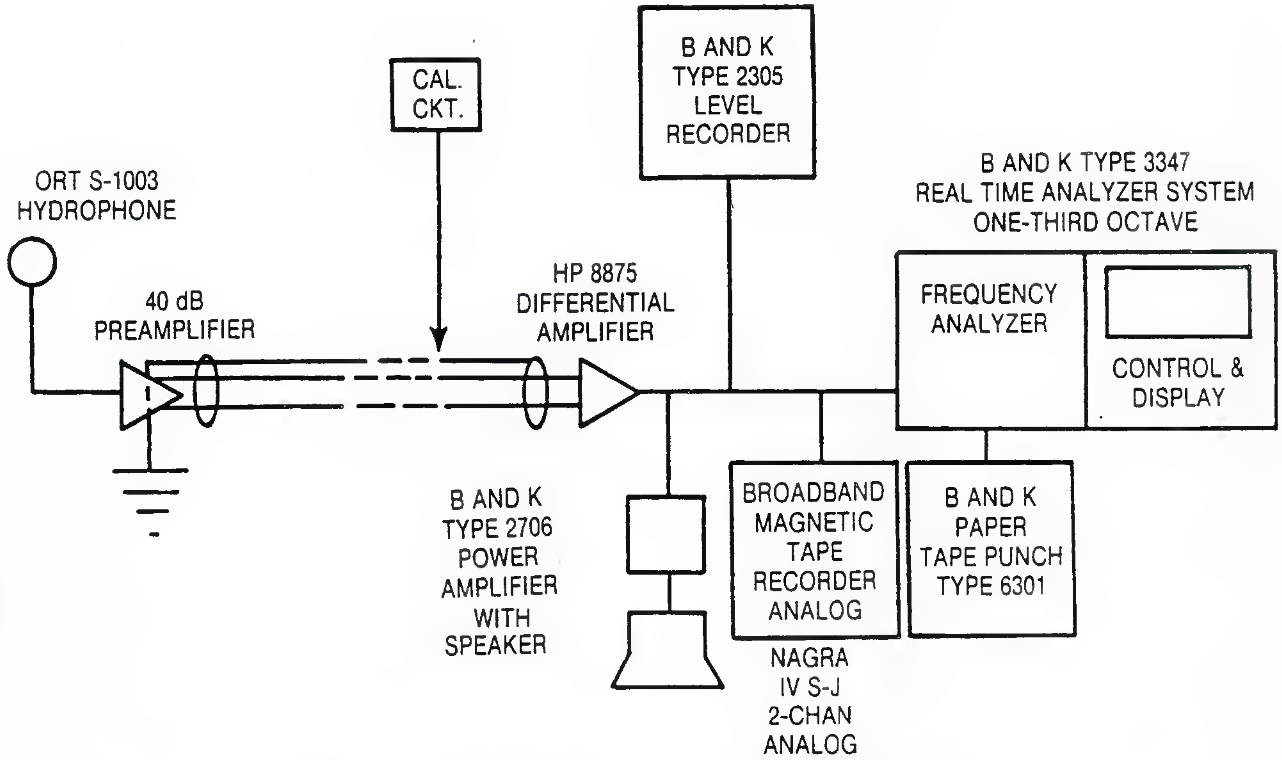


Figure 3-4. Range of Ambient Noise Spectrum Levels

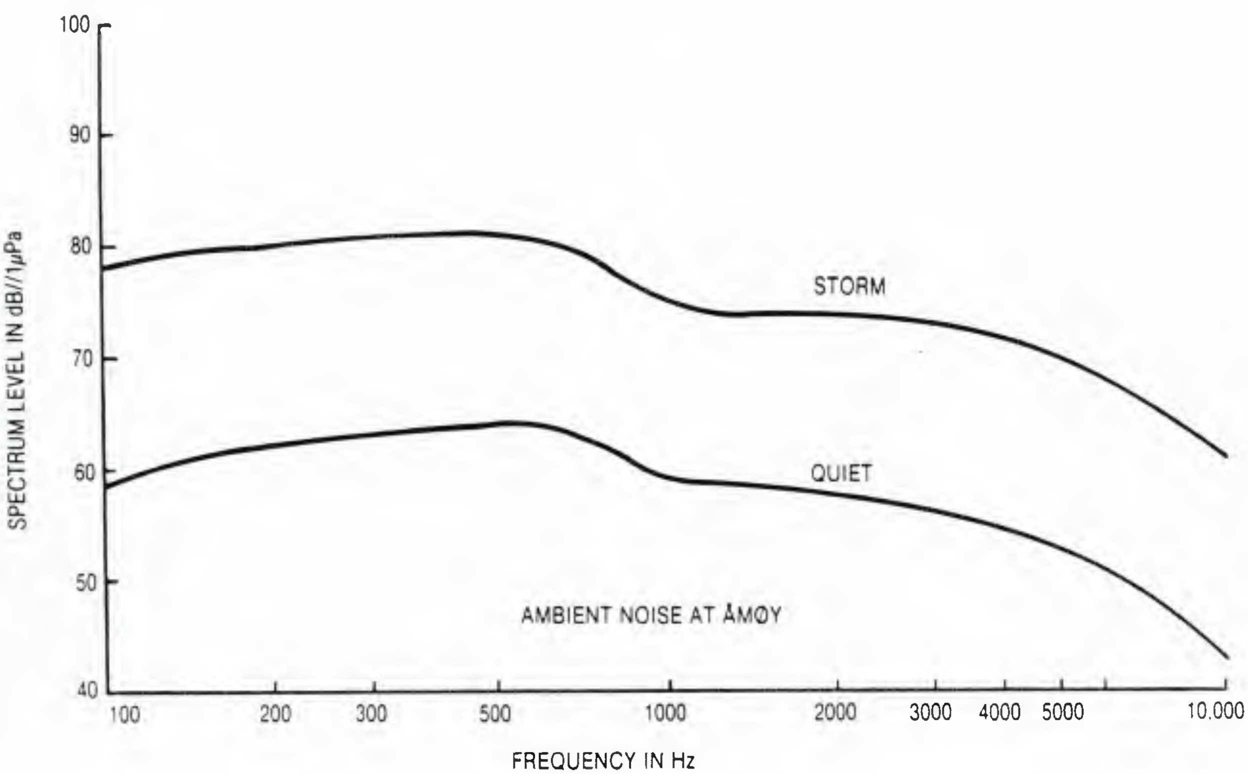


Figure 3-5. Aamøy Range Measurement and Data Recording System

Additional Comments (Cont'd):

As can be seen in Figure 3-4, the station instrumentation essentially constitutes a single channel measurement system such that only one hydrophone at a time is used. (That is, the Static and the Dynamic Ranges would not be operated simultaneously.)

The Brüel & Kjaer Real Time One-Third Octave Frequency Analyzer is normally operated using all bands from 12.5 Hz to 80 kHz (with the exception of the 50 kHz filter which is eliminated due to interference from a Ranging Echosounder).

Other measurement instrumentation available at the Aamøy Measurement Station includes a Brüel & Kjaer Maximum Spectrum Selector (Type 5614) as well as an X-Y Plotter and a variety of such standard instruments as signal generators, volt-ohmmeters, oscilloscopes, and power supplies.

The digital punched paper tapes are sent to the Navy Materiel Command in Bergen for analysis and plotting. The magnetic tapes are also sent to Bergen as backup.

Currently all computing in connection with the Aamøy Range data is done in Bergen on an HP 9826.

There is a plan to improve the automation of the Stations. The paper tape punch will be eliminated to be replaced by an online digital magnetic recording.

It is intended that the Measurement Station be provided shortly with the same computer that is currently used in Bergen (HP 9826), with an eight color HP Plotter. The intent is that the plotter will interface directly with the computer output so that final results will be available for examination very soon after a run is completed and online decisions can then be made.

No changes to the in-water parts of the Aamøy Range facilities are contemplated.

Date of this Summary
7 August 1985

Facility Name: Norwegian Underwater Technology Center A/S

Location: Approximately 3.4 mi./5.5 km. southwest of Bergen center, in Laksevaag, on the south shore of Byfjord (off Gravdalsveien)

Cognizant Organization: An independent incorporated non-profit company whose stock is owned by three Norwegian oil companies: Statoil, Saga Petroleum, and Norsk Hydro A/S (51% government owned)

Facility Functional Name: NUTEC

Major User(s): Oil companies, Norwegian government, Norwegian Navy

Technical Areas Supported: Underwater communications, acoustic telemetering, diving safety, divers' equipment, helium speech unscrambling, divers' mask noise

Unique Features: Large mobile platform (NUTEC Fjordbase) with centerwells and 200-US ton/179-British ton A-frame, revolving crane, multiple winches, a four point mooring system, computers, azimuth propulsion thrusters, Decca and Subsea navigational system

Significant Equipment Available: Pressure test vessel 4400 psi/300 bars; a two-man tethered submersible, support ship for submersible, divers' pool, hyperbaric complex

Local Environment: Very quiet, on the south shore of Byfjord, located on property leased from the Norwegian government. Byfjord is a fjord 985 ft./300 m. deep with a relatively flat sand bottom or, in some areas, with 165-200 ft./50-60 m. of clay over sand. The BT in Byfjord is similar to that in the vicinity of the offshore oil installations.

Future Plans for Facility: Presently constructing a new, large test hall and assembly hall for testing offshore equipment. It is planned to build a subsea navigational and positioning calibration range in Byfjord.

Facility Mailing Address: Norwegian Underwater Technology Center
Gravdalsveien 255
P.O. Box 6
N-5034 Ytre Laksevaag, Bergen
Norway

Local Contacts: Mr. Odd Havre, Underwater Technology Division Head
Mr. Jan Åke Lundblad, Instrumentation and Measurement Analysis
Tel: Int. Oper. + 47 5 34 1600

Contact for Access/Scheduling:
For submersible: Mr. Steinar Evensen - Underwater Intervention
For mobile platform: Mr. Olav Bakke - Maritime Operations
At above address and telephone

Narrative Description: NUTEC was founded in 1981 as an independent non-profit organization to provide a national center for the test and evaluation of underwater equipment and systems, to provide a center of competence for diving technology and hyperbaric medicine and to perform R&D in all relevant areas of underwater technology.

In January, 1985, NUTEC was reorganized and incorporated as a limited company with three stockholders: Statoil (60%), Saga Petroleum (10%), and Norsk Hydro (30%). Norsk Hydro is 51% owned by the Norwegian government.

In terms of man-hours of effort expended at NUTEC, it is estimated that 5% is on research; 10% is on applied research (including diving research); 30% is on applications directed R&D; and 55% is on operations and applications.

The fraction of the above devoted to underwater acoustics is not large. Nevertheless, there is some significant work in this area.

One ongoing program is in the area of helium speech unscrambling. A prototype computerized unscrambler has been built which works in the frequency domain. Effort is now directed toward development of a more portable unit and toward improved software for new unscrambler algorithms.

Another effort in the general area of diver communications is an attempt to produce a suitable noise-cancellation circuit for the reduction of divers' "mask noise" (breathing noise) which constitutes a severe interference.

In the more general area of underwater acoustic communications, there are studies to examine the feasibility of acoustic communications between center and satellite wells on the bottom, and between bottom installations and surface craft.

There is also an ongoing examination of the feasibility and/or the need for underwater acoustic telemetry in connection with the offshore oil installations. In particular, the feasibility of underwater acoustic telemetry over ranges of 6-12 mi./10-20 km. is under study, considering such possible applications as the opening or closing of a valve or switch after periods of non-use of weeks or months. The intent is to conduct tests of the performance of a variety of acoustic telemetry links over extended periods. (NUTEC has worked with Honeywell Offshore in Seattle on this problem as well as with Johns Hopkins APL.)

Another area of study at NUTEC is that of underwater acoustic navigation and positioning. It is intended that a navigational/positioning calibration range with carefully positioned transponders be installed in Byfjord. Ships with a need for precise underwater acoustic positioning would use this range to evaluate the accuracy of the ship's positioning capability and would use it as a training tool when appropriate.

Computer applications in the acoustics area include efforts toward modelling of hydroacoustic sound transmissions, including boundary effects and oceanographic parameters. The software will be used for evaluating offshore hydroacoustic transmission systems and for studies of underwater noise propagation.

Narrative Description (Cont'd):

Acoustic imaging for underwater viewing has been studied at NUTEC both theoretically and experimentally. Measurements on the experimental reconstruction of sound fields for acoustic viewing have been pursued in cooperation with the Dept. of Physics at the University of Bergen. In addition, several system configurations have been simulated in software.

NUTEC has accumulated a number of excellent facilities, only some of which were developed in support of the above acoustic programs. Other facilities, developed for totally unrelated purposes, nevertheless offer features potentially invaluable for certain acoustic studies.

One such major facility is the 2000-US ton/1786-British ton mobile platform (TRV NUTEC Fjordbase), pictured in Figure 3-6.

"Fjordbase" was constructed in 1982. The crew, with the exception of the Captain and Chief, is provided by long-term contract with a drilling company (the same company that provides the crew for the submersible support vessel).

The specifications describing the capabilities of this versatile work platform are listed in Table 3-1.

Another very specialized facility is the two-man tethered submersible "Checkmate" and its support vessel "Deep Sea Inspector."

Figure 3-6. NUTEC Fjordbase

Table 3-1. Specifications of TRV NUTEC Fjordbase

Registration:
Norwegian
Homeport:
Bergen
Class:
VERITAS = 1A1 R5 Pontoon DFS
Dimensions:
Length overall .... 65.00 m
Breadth moulded .... 22.0 m
Depth moulded .... 3.8 m
Operational draft .... 1.8 m
Tonnage:
Register tonnage .... abt. 1420 BRT
Deadweight .... abt. 2000 TDW
Capacities:
Marine diesel oil .... 85 m^3
Fresh water .... 85 m^3
Ballast water .... 1.700 m^3
Store rooms under deck .... 240 m^2
Moonpools:
Main moonpool 10×8 m
Extended moonpool 4×30 m
with flotation pontoon covers
Deck loads:
Free deck area aft of moonpool .... 720 m^2
1. General carrying capacity .... 2.5 t/m^2
2. 288 m^2 carrying capacity .... 10.0 t/m^2
3. 2 pcs point loads carrying cap .... 100.0 t/m^2
4. 24 pcs point loads carrying cap .... 200.0 t/m^2
5. Trolley on rails from stern to slit
moonpool .... 300.00 t/m^2
Sheerleg crane (A-frame) MTT:
Main hook, offshore type hook block .... 200 t SWL
Load indicator type PIAB
Auxiliary hook, offshore type service block ... 20 t SWL
All winches hydraulic, Karm
Revolving crane:
30 t at 10 m outreach
15 t at 22 m outreach
Winches & deck machinery:
4 main winches, Karm for handling of equipment through moonpool or over the sides. Hydraulic drive. Max wiredrum capacity on each winch 1000 m 20 t SWL
1 tugger winches 5 t SWL, 3 t eff. working load, Atlas Copco
4-point mooring:
4 each positioning high holding power anchors, Stevin 1000 kg and Stevmud 3000 kg on 1200 m wire rope.
Hydraulic anchor winches Karm.
Rope tension and length measurement. Reg. Tek ALH-48.
Accommodation:
The accommodation is built up of ISO-standard 20" steel containers and contains 4 double cabins 2 single cabins which together with changerooms, galley, mess, conference room and instrument room are arranged forward on second deck.
3 movable containers for project team are arranged aft on the maindeck.

Propulsion:
2×478 kW/650 hp Schottel Navigator, azimuth thrusters, driven by Deutz diesels.
Service speed: 6 knots.
Rig floor (drill floor) and substructure:
Height above main deck: 10 m mounted on four pads over main moonpool and equipped as follows:
Overhead trolleys:
2×50 t SWL, Sverre Munck, for combined or single lift
Guideline winches:
7×5 t SWL 3 t Eff. working load, Atlas Copco, constant tension. All operated from console at main moonpool side.
Tugger winches:
2×1.5 t SWL 1.5 Eff. working load, Atlas Copco, located on rig floor.
Rotary table:
Flush deck 37½", National C-375, situated over the center of the main moonpool, non-powered and removable.
2 sheaves for hydraulic umbilical.
Subsea module transfer:
The rig floor is fully equipped for handling of heavy lifts through the moonpool. For this purpose the A-frame and drill string will be utilized. The A-frame main hook acts at travelling block.
Drill floor equipment:
2 spinnerhawks, Weatherford Lamb.
1 hydr. cathead, WHP SMF International.
2 rotary tongs, AAX Web Wilson with davits.
1 rotary slips, Varco, for 5" drill pipe.
1 set links, Web Wilson, 250 tons.
Navigational aids:
Gyro compass, Robertson
Radar, Decca 45.
Surface site navigation.
Decca trisponder system.
Underwater site navigation.
SIMRAD HPR-309 ultra short baseline system.
Echosounder, Furuno FE-606.
Wind gauge, Walkers.
Communication:
2 VHF SAILOR 143, all marine channels.
7 UHF portable intercom system.
Panasonic mobile telephone DWCA 2000.
Pick up boats:
1 Weedooboat with 80 hp Mercury outboard engine.
1 Buster 13' with 20 hp Mercury outboard engine.
Power supply:
1×300 kW driven by Deutz diesel rating 440 hp.
Electric alternators - 2×165 kW driven by Deutz diesels each rating 440 hp. PTO for hydraulic power.
Electric alternator 1×75 kW driven by Deutz diesel engine.
Working air:
3 compressors, Atlas Copco, each 13m^3/against 8 bar.
Divers' air compressor and air storage.

Narrative Description (Cont'd):

The Checkmate working space is an acrylic sphere which provides a 360° horizontal field of view. The sphere containing the pilots will be positively buoyant and can be jettisoned in an emergency.

Checkmate is provided with both active and passive sonar systems, with an underwater telephone, and with an acoustic underwater navigation system among other features.

Checkmate is shown pictorially in Figure 3-7 and in diagrammatic profile in Figure 3-8.

Specifications, onboard equipment, and options are listed in Table 3-2.

The support vessel for the two-man tethered submersible is the DSV, "Deep Sea Inspector," a 125-ft./38.9-m. converted ferry boat, shown in profile in Figure 3-9.

The Deep Sea Inspector is chartered from a drilling company on a long-term basis. The drilling company provides the crew as well, except for two submersible pilots and a four- or five-man submersible team. Specifications and available equipment for Deep Sea Inspector are listed in Table 3-3.

NUTEC has assembled a complex of four hyperbaric chambers flanged together for use in diving research, including two simulated deep submergence (1640 ft./500 m.) living chambers, a work chamber (equivalent depth--2132 ft./650 m.) and a wet/dry transfer chamber (equivalent depth--1640 ft./500 m.). The work chamber can be used all dry, with one part filled with water, or completely filled with water. In this last case, the chamber, which is a cylinder 23.3 ft./7.1 m. long with a diameter of 9.8 ft./3 m., can be pressurized to 960 psi/65.3 bars and can be used for pressure testing relatively large pieces of equipment.

In addition, there is a fifth chamber used only for pressure testing and unmanned equipment trials. Maximum depth for this chamber is 4410 psi/300 bars. The inner length of this cylindrical chamber is 6.1 ft./1.87 m. and the inner diameter is 2.3 ft./0.7 m.

A test pool (see Figure 3-10) is available primarily for functional testing of divers and equipment.

The pool is not equipped for acoustic measurements but could certainly be used for such purposes. The pool water can be cooled or heated to achieve temperatures between 32° and 91.4° F/0° and 33° C. An overhead gantry crane facilitates the handling of large or heavy (to a maximum of 12.5 US tons/11.2 British tons) pieces of equipment. Height from the crane hook to the top edge of the pool is 11.3 ft./3.45 m. The water depth is also 11.3 ft./3.45 m. Dimensions of the pool are 23 x 16.4 x 11.3 ft./7 x 5 x 3.5 m. deep. The pool is provided with two viewing ports near mid-depth at one end of the rectangular tank.

Computer equipment includes a Digital VAX 11/750, a PDP 11, and a PDP 11/34. Other associated equipment includes an AP400 Analog Array Processor (for speech processing), a Datel Systems PDAS250 for high speed sampling, an HP 8-color X-Y plotter, an HP Data Logger, and a Wavetek System 716 16-channel filter.

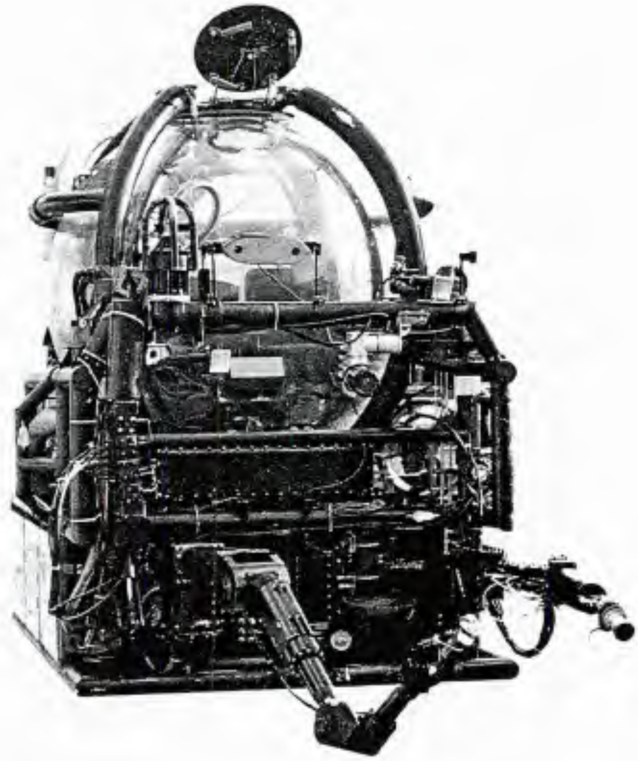


Figure 3-7. Checkmate -- A Tethered Two-Man Submersible

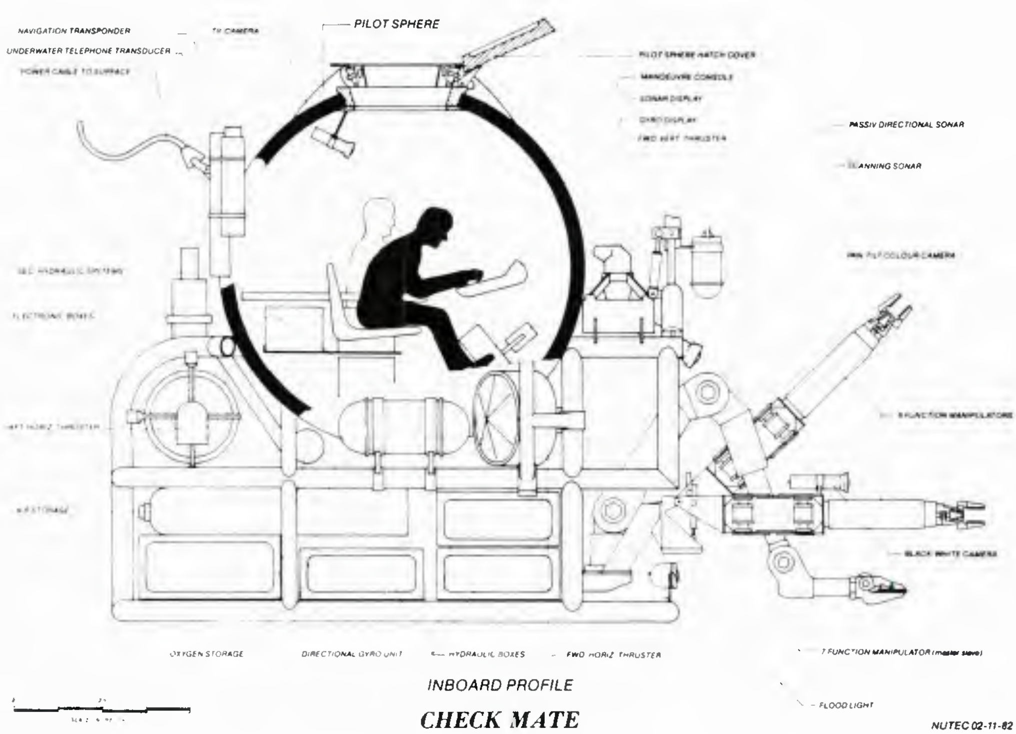


Figure 3-8. Checkmate in Profile

Table 3-2. Checkmate Specifications and Equipment

Dimensions:	
Overall	
Length	3.25 m
Beam	2.60 m
Height	3.15 m
Draft	3.15 m
Weight	7000 kg
Payload	300 kg
Pilot Sphere	
Spherical shape	1900 mm I.D.
Thickness	79 mm
Internal volume	3.59 m^3
Hatch clear opening	535 mm diam.
Material	Acrylic plastic
Operating characteristics:	
Depth:	
DnV classification	325 m
Collapse depth	1100 m
Speed:	
Horizontal	3 knots
Vertical	2 knots
Life Support:	
Duration	240 man hrs.
Carbon dioxide scrubber	
Emergency breathing equipment	Three
Metabolic oxygen bleed	
Oxygen monitor and alarm	
CO_2-monitoring	
Power:	
Umbilical (700 m)	65 kW (85 kW peak)
Emergency batteries	24 v, 108 Ahr

Onboard equipment:
- One 7-function manipulator (master/slave)
- Two 6-function manipulators (on/off)
- Two separate hydraulic transformers for manipulators and tools
- Hydraulic vice
- Scanning sonar
- Passive directional sonar
- Acoustic underwater navigation
- Directional gyro
- Hard wire telephone
- Underwater telephone
- VHF transceiver
- External lights (3250 W in total)
- External pan/tilt colour TV-camera
- Black/white TV-camera on manipulator
- Black/white TV-camera inside sphere
- Video recording equipment
- Still cameras
- Fire extinguisher (Hallon 1301)

Options:
- Lifting claw
- Hydraulic brush
- Hydraulic cutter/grinder
- Hydraulic impact wrench
- Hydraulic wirecutter
- Water/sandblaster
- Thickness measuring equipment
- CP-reading equipment
- Selection of manipulator claws
- Stereo camera system
- Suction cups

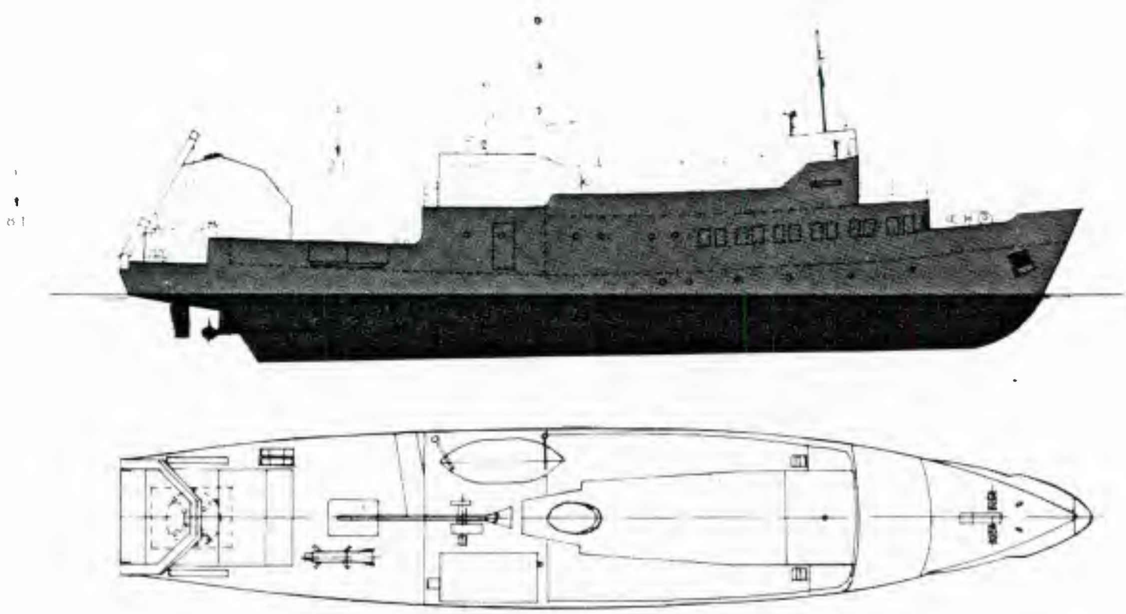


Figure 3-9. Deep Sea Inspector -- Support Vessel for Two-Man Subersible

Table 3-3. Specifications for Deep Sea Inspector

Sign. LRT: LMHM
Class: DNV IAIK-Ferry-IS
Tonnage: 206 grt/83 nrt.
Speed: 11.5 knots

Main engine: 2 x 214 BHP Deutz - twin screw
Auxiliaries: 1 x 53 hp and 1 x 38 hp Lister (220V AC)
Aggregate: 1 x 153 kVA (hydr. pump + Checkmate Supply)
Capacities:
Fresh Water: 7.0 tons
Water Ballast: 10.5 tons
Bunker Capacity: 10 tons
Lifting gears: 1 derrick 6.0 m/2.0 tons
1 A-frame swl. 8.0 tons
Winches: 1 2.0 tons deck winch W/2 hook
1 mooring winch W/2 hook
Accommodation: 12 beds in cabins. 2 Day-rooms w/Galley
Work boat: 16 ft. inflatable

Dimensions:
L.o.a.: 38.86 m.
L.p.p.: 34.50 m.

Breadth mid.:	7.00 m.
Depth mid. main dk.:	3.10 m.
Operation draft:	2.6 m.

Electronics:
Radar
Echosounder
Trek-point
Decca-Trisponder
Communication:
VHF
Mobile telephone
UHF
AIR DIVING-STATION

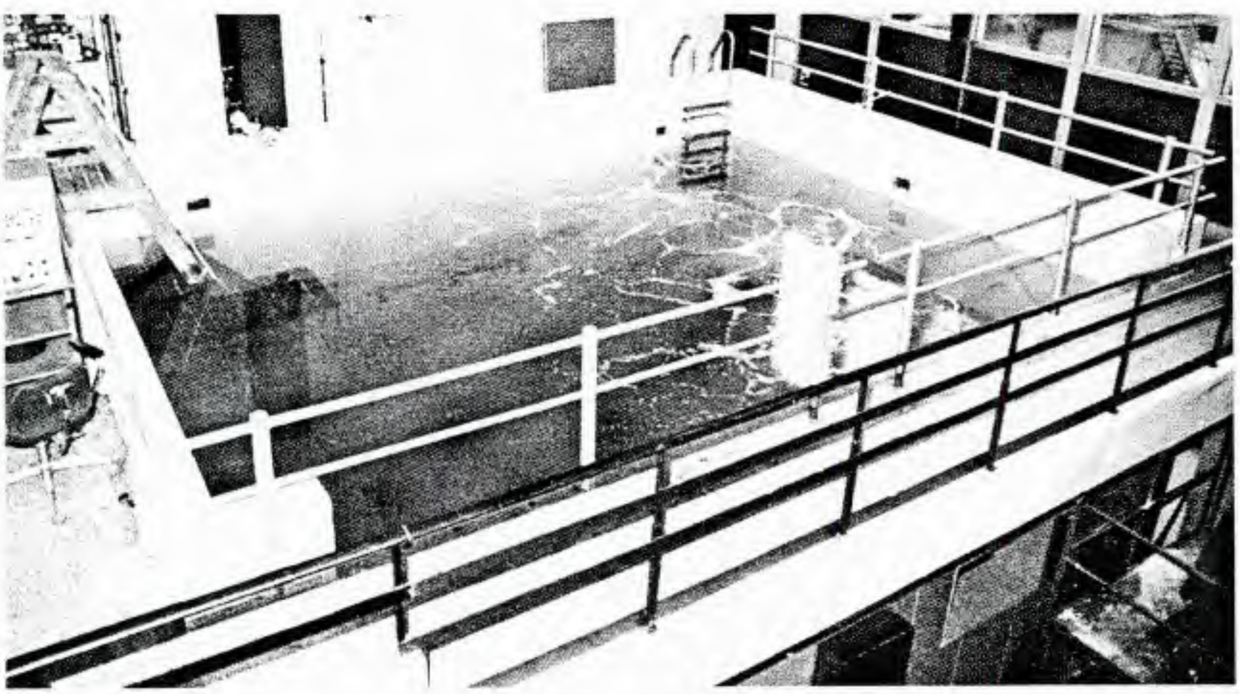


Figure 3-10. Divers' Test Pool

Narrative Description (Cont'd):

Computer access is distributed throughout the facility to the far end of the pier.

As stated earlier, future plans for the NUTEC facilities include construction of a new 78 x 138 ft./24 x 42 m. assembly test hall to test large offshore equipment. It will be provided with a 60-US ton/53.6-British ton overhead crane initially (52.5 ft./16 m. under the hook) to be upgraded to 120-US ton/107.2-British ton at a later date. The front doors will provide an access measuring 52.5 x 50.8 ft./16 x 15.5 m.

Date of this Summary
9 August 1985

Facility Name: Institutt for Kontinentalsokkelundersøkelser og Petroleumsteknologi A/S (IKU); in English: Continental Shelf and Petroleum Technology Research Institute, Ltd.

Location: On or just off of Haakon Magnussons gt. in the extreme northeast section of the city of Trondheim, 2296 ft./700 m. from the Trondheim Fjord on the west coast of Norway.

Cognizant Organization: SINTEF Group

Facility Functional Name: IKU Exploration Technology Dept.

Major Customer(s): International oil companies and other North Sea operators, such as well-logging companies and survey companies

Technical Areas Supported: Marine geological and bathymetric surveying and mapping

Special Programs Supported: Exploration and surveying of the Norwegian Continental Shelf; oil spill drift prediction, control and cleanup

Significant Equipment Available: Deep towed seismic source; SIMRAD ultrasonic current meter; EG&G/Vector current meter; Aanderaa current meter; NORWAVE buoy for measurement of wave height, wave direction, wind speed, wind direction, air/sea temperatures, and barometric pressure; all data internally recorded and transmitted to shore via ARGOS satellite system; and digital computer systems including an ND-570/CXA, a VAX 11/780, two PDP 11/24 systems and a PDP 11/23 system; bottom coring devices

Local Environment: IKU is currently spread out among several leased buildings in a quiet neighborhood on or just off of Haakon Magnussons gt. on the outskirts of Trondheim, approximately 2296 ft./700 m. from the Trondheim Fjord.

Future Plans for Facility: Construction of a new building is expected to be completed in 1988. This new building will be IKU-owned and will be located on the outskirts of the Technical University of Norway. It will allow the entire company to be consolidated in a single building.

Facility Mailing Address:

Continental Shelf and Petroleum Research Institute, Ltd.
Haakon Magnussons gt. 1B
P.O. Box 1883 N7001
Trondheim
Norway

Local Contacts: Dr. Jens Hovem
Department Manager, Exploration Technology Department
Tel: Int. Oper. + 47 7 92 0611

Contact for Access/Scheduling: Dr. Jens Hovem, at above address and telephone

Narrative Description: IKU is a member of the SINTEF Group. SINTEF is an acronym for Foundation for Scientific and Industrial Research at NTH. SINTEF is an independent organization which, although non-profit, is nevertheless commercially oriented and is required to avoid losing money each year. Five percent of SINTEF funding comes from the Norwegian government and the balance is derived from commercial contracts. SINTEF is "integrated with" NTH (Technical University of Norway) and many of the SINTEF staff are also on the staff and/or faculty of the University. Any government funds received by a member laboratory go to SINTEF for redistribution. SINTEF funding sources are:

Industrial Contracts -- 73%
Research Projects -- 20%
Fixed and General Government Funding -- 5%
Other Sources -- 2%

The relationship between SINTEF and the member laboratories and the interrelationship among the several laboratories is shown in Figure 3-11.

As indicated in Figure 3-11, IKU is a limited company totally owned by SINTEF, with a staff of approximately 200 people. IKU is not involved in underwater acoustics as such, but is involved in a number of studies which require the use of acoustic devices (such as the IKU-developed side-looking sonar for bottom surveys) and many of which generate environmental data which are potentially in direct support of any acoustic studies in those regions (Norwegian Atlantic Shelf, coastal areas, North Sea and the Barents Sea).

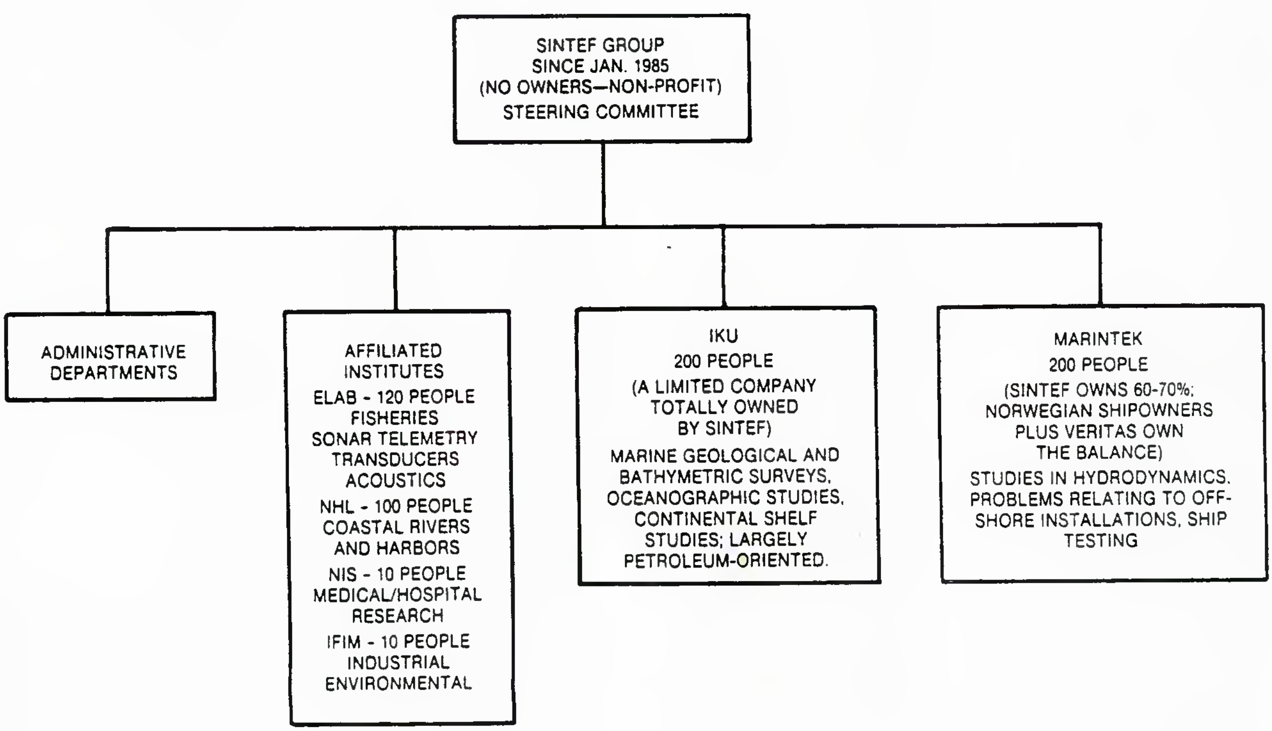


Figure 3-11. Organization of SINTEF

Narrative Description (Cont'd):

IKU specializes in marine geological and bathymetric surveys and mapping. IKU conducts their own oceanographic studies including long-period recordings of wind, waves and currents in the area of interest as well as the collection and analyses (porosity, permeability, acoustic velocity) of bottom cores and bottom grab samples. IKU performs seismic studies using in-house developed towed bottom-penetrating sonars. The immediate purpose of most of the IKU survey work is in support of oil prospecting efforts and oil field development, including undersea pipe/cable laying and protection.

The IKU surveys are single-ship operations. IKU does not own or maintain a permanently based vessel but contracts for survey ships as needed.

Foreign oil companies are no longer required to contribute a specific fraction of their profits to R&D in Norway, but they are required to become Norwegian limited companies (A/S) and are encouraged to help in the development of Norwegian industry. Shell, ELF (French), and AGIP (Italian) are some of the participating companies.

IKU performs very little work directly in connection with the Norwegian Ministry of Defense, although others in the SINTEF Group do.

Another substantial IKU effort is in the area of well-logging, again in support of the petroleum industry. The IKU work in this connection consists mainly of computerized model studies.

The organization of IKU and the distribution of effort within the organization is given in Figure 3-12.

IKU compiles all of the bathymetric, seismic, and oceanographic information obtained (including bottom coring data) and generates maps and charts which are then made available for general sale and distribution.

IKU is currently involved in a survey of areas in the Barents Sea which lie in Norwegian Coastal Waters. This survey was initiated in 1984 in cooperation between IKU and Exxon ($10M), but now 12 oil companies are participating. The survey includes shallow seismic surveys, deep reflection studies, bottom sampling (cores, grab samples, and scoop samples), and heat flow measurements.

As noted in Figure 3-12, the readiness responsibility for survey instrumentation and environmental sensing/recording instrumentation resides in the Exploration Technology Department under the direction of Dr. Jens M. Hovem. Similarly, the design and development of new survey/oceanographic instrumentation is the responsibility of that department. The 4-man Field Operations Group, which normally operates this instrumentation at sea, is located in the same department.

Extensive geological mapping of the geographical area indicated by the cross-hatching survey lines in Figure 3-13 has been completed, and the printed maps are available.

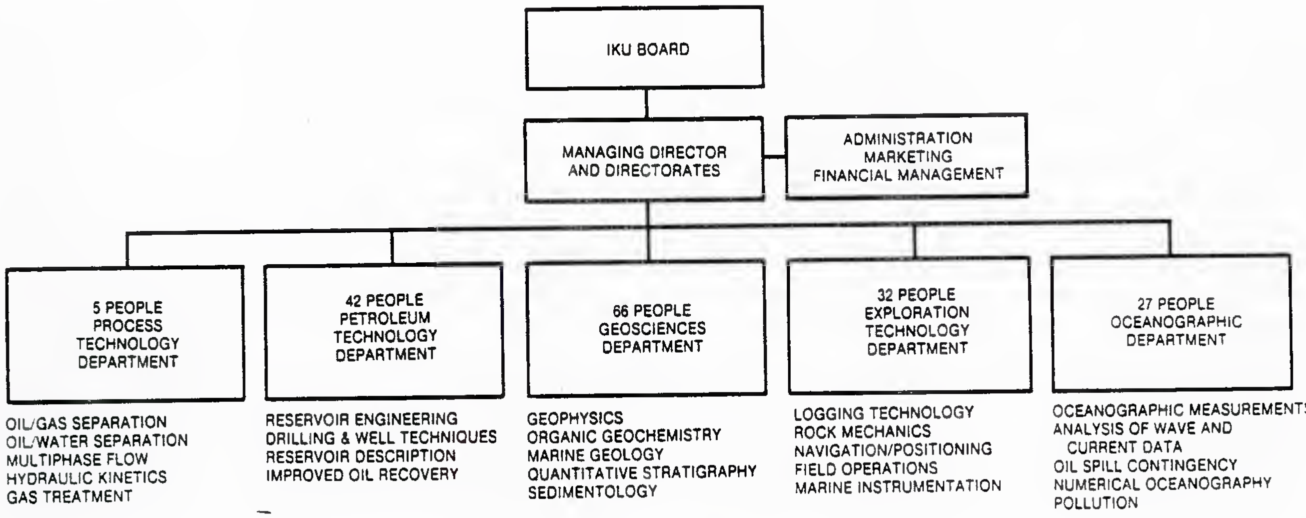


Figure 3-12. Organization of IKU

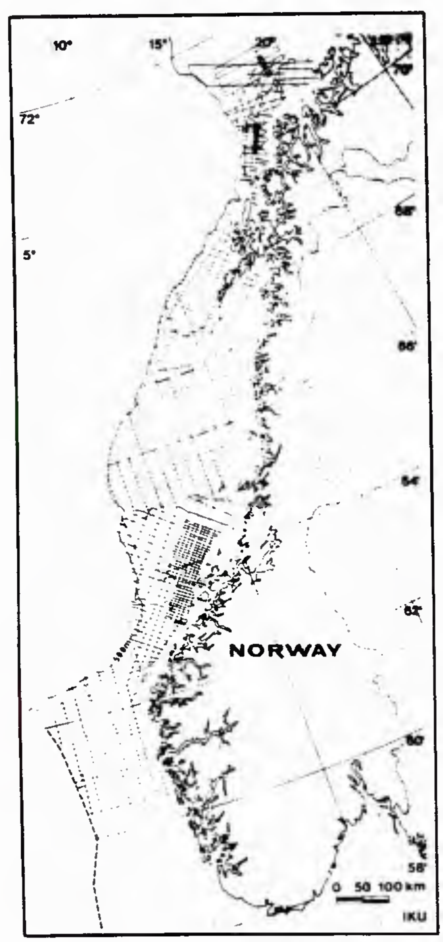


Figure 3-13. Area of IKU Completed Surveys

Narrative Description (Cont'd):

Bottom sampling equipment available in the IKU Exploration Technology Department includes:

Gravity Corers
Vibra Corers -- 9.8 ft. & 19.7 ft./3 m. & 6 m.
Rock Drill (Bedford Institute) -- 19.7 ft./6 m.

A Waverider type of surface wave measurement buoy that IKU has used since 1980, known as the NORWAVE wave direction measurement buoy, is shown in diagram in Figure 3-14(a) and is pictured in use in Figure 3-14(b). This unit was developed jointly by IKU and the Christians Michelsens Institute and is manufactured by Bergen Ocean Data.

A second generation wave direction measurement buoy has been developed in-house by IKU and is shown in Figure 3-15.

IKU has available a number and variety of current meters for use at various depths. These are:

UCM-V1 Ultrasonic Current Meter (SIMRAD)
VCCM Vector Measuring Current Meter (EG&G)
RCM-4 Current Meter (Aanderaa)

In addition, IKU has developed a fiber optic rotational coupling and cable for transmission of data from the submerged current meter to a surface buoy for retransmission to shore via the ARGUS satellite system.

Drifters are used to determine surface drift (largely used for oil spill drift predictions).

IKU has available the Deep Towed System shown in Figure 3-16. This system was developed in-house for seafloor mapping and includes a high resolution seismic source (a Boomer, custom-built for IKU by Huntec in Canada), for medium penetration and a Klein Associates 50 kHz, dual-channel, side-scan sonar. The fish is positioned relative to the ship by a hydroacoustic system. This system can be used in seas up to a state 6, and has been used primarily in connection with studies of pipeline routes (gas, oil).

In addition, IKU has done preliminary work on a system called TOPOSS (TOPOgraphic Side Scan Sonar), which IKU has licensed to SIMRAD Subsea for production. The final models are not yet available.

A list of computers available to the Exploration Technology Department at IKU includes two large systems, an ND-570/CXA and a VAX 11/780.

Smaller computers include two PDP 11/24 systems and one PDP 11/23 system.

Seagoing computers are generally the smaller HP systems and are used principally for preliminary data analysis and examination to determine that all systems are functioning properly.

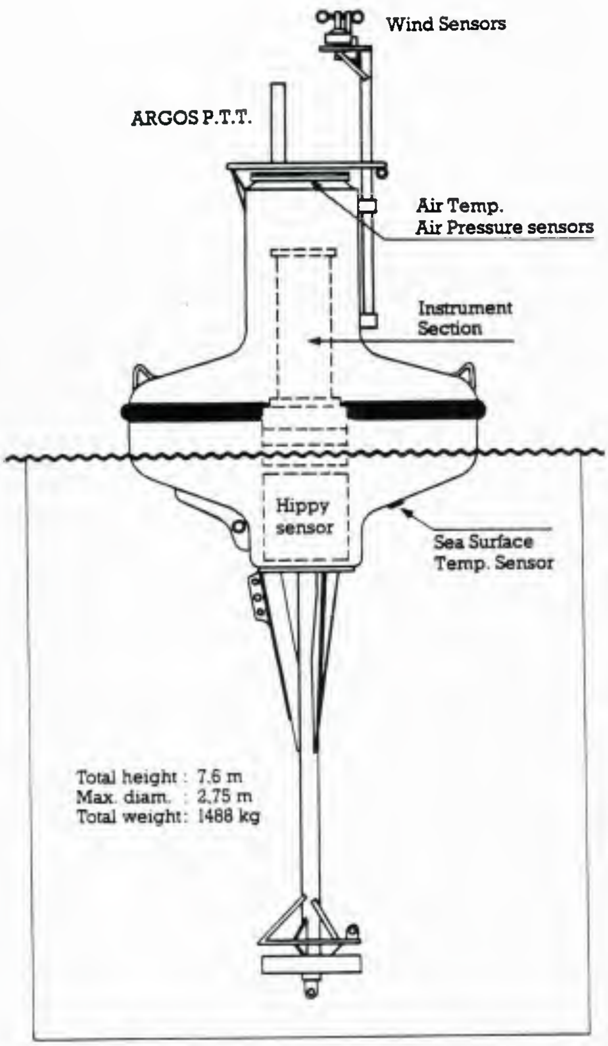


Figure 3-14(a)

Wave sensors:	*Datawell heave/pitch/roll sensor Hippy 40 or Hippy 120. Aanderaa compass 1248.*
Meteorological sensors:	*BOD 3 cup anemometer, wind vane and Aanderaa compass. BOD thermistors for air and sea temperature measurements. BOD aneroid capsule for air pressure measurement.*
Data storage:	*SEA DATA digital tape recorder. Variable recording interval and sampling frequency.*
	The data capacity is 60 days for the default 1 Hz/17 min/3h measuring mode.
Buoy surveillance:	*ARGOS system for automatic positioning and data transfer of internal instrument checks, meteorological data and in situ processed wave data.*

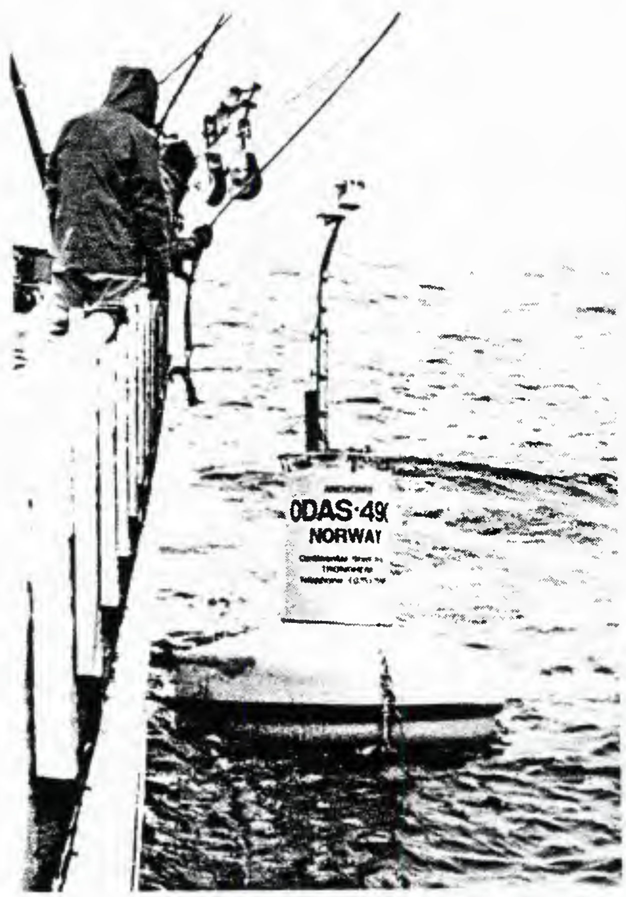
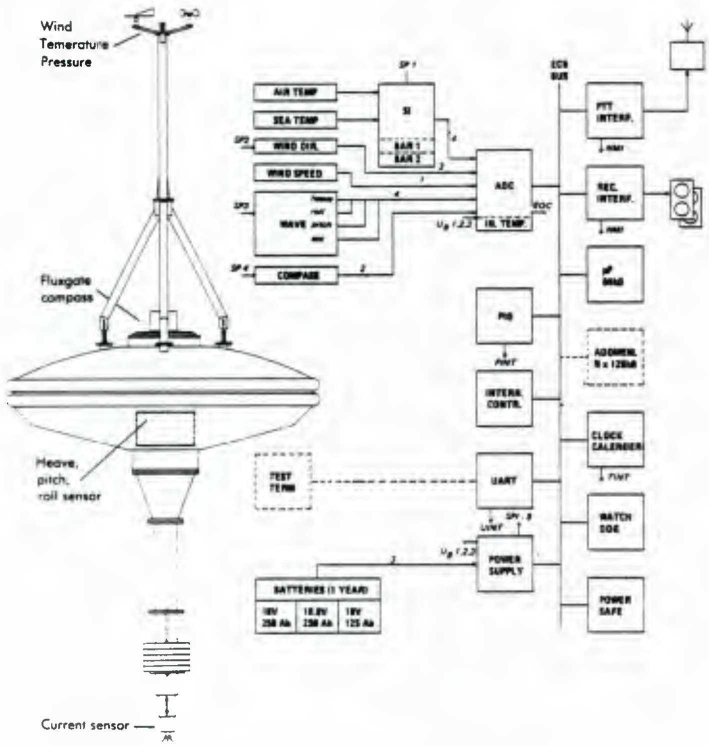


Figure 3-14(b)

Figure 3-14. NORWAVE Wave Direction Measured Buoy



Buoy characteristics

Weight:	850 kg
Diameter, max:	2.9 metre
Height overall:	6.75 metre
Buoyancy max:	3.75 m^3
Natural freq. pitch:	2.3 sec
Material:	Fiberglass, dinyvicell, aluminium

SENSORS

Wave:	Datawell Hippy-40.
Compass:	Digicourse 101E (fluxgate)
Wind:	Brookes And Gatehouse Mod. 152/211.
Barometric pressure:	AME 880Solid Statesensors.
Air and sea temperature:	Aanderaa 2775 and 1229.
Current:	Simrad UCM-30.
Windsensor height:	3.5 m

Figure 3-15. Second Generation Wave Direction Measurement Buoy

Figure 3-16. IKU Deep Towed System

Date of this Summary
12 August 1985

Facility Name: ELAB (Elektronikklaboratoriet, Undervannsteknikk)

Location: At the Norwegian Institute of Technology (NTH) in Trondheim, Norway. Off Høgskoleveien, approximately 1.1 mi./1.8 km. south of the city center.

Cognizant Organization: SINTEF

Facility Functional Name: ELAB Underwater Acoustics Group

Major User(s): Petroleum industry, sonar manufacturers, fishing industry

Technical Areas Supported: Transducer development, acoustic telemetry, underwater communications

Unique Features: Location in the Electrical Engineering building of the Norwegian Institute of Technology and access to NTH faculty and facilities

Significant Equipment Available: Acoustic measurement/calibration tank with rotator and plotter; tone burst timing generator; sampling log voltmeter; two gating systems; audio power amplifier; RF power amplifier; one-quarter inch 4-channel tape recorder; four standard (reference) hydrophones

Local Environment: University campus location (NTH), in a very quiet section 1.1 mi./1.8 km. south of the city center.

Future Plans for Facility: Three year acoustics program concerned with telemetry for offshore installations and associated control functions. Another project planned involves a multipath cancellation study for mobile communications.

Facility Mailing Address: ELAB-SINTEF Group
N-7034 Trondheim-NTH
Norway

Local Contacts: Mr. John Dalen
Manager, Maritime Systems
Tel: Int. Oper. + 47 7 59 2600

Narrative Description: ELAB is another member laboratory of the SINTEF Group (see comments on SINTEF under IKU entry) and again is integrated with the Norwegian Institute of Technology (NTH). ELAB is actually resident on-campus, in the Electrical Engineering building and many of the staff serve both NTH and ELAB.

ELAB has a total staff of approximately 140. There are 12 technical groups with staffs averaging 9 persons each, with the balance providing management and support.

Narrative Description (Cont'd):

The Underwater Acoustics Group at ELAB is an eight-man group within the marketing division "Offshore and Maritime Systems" headed by Mr. John Dalen and is organizationally located under "Transmissions Systems." (There is also an "Acoustics Laboratory" at ELAB which is comprised of three other groups: Electroacoustics, Noise and Vibration, and Architectural Acoustics.

The work of the Underwater Acoustics Group has mainly been in three categories:

Fisheries Research Work -- 50%
High Frequency Transducer Design and Production -- 10 to 20%
Other sonars, telemetry -- 30 to 40%

There is considerable interest in fishery research towards improving knowledge of the zooplankton as fish food and their total role in ecosystems. In particular, there is interest in guarding systems, in size distributions and in food quantity control in aquaculture plants (i.e., detection of food particles falling below fish feeding). The Underwater Acoustics Group is currently designing a shipborne multi-frequency plankton sonar system for estimating size distributions, biomasses and geographical distributions of fish and zooplankton.

The group has been called upon to make ambient noise measurements and, in response to special requests, has made several ship radiated noise measurements.

Propeller cavitation/noise measurements have been made (see Figure 3-17) generally on fishing vessels for the Fisheries Research Office and also at the request of independent vessel operators considering propeller changes.

Transducer design and construction has been in the frequency range of 10 kHz to 2 MHz. (Other groups at ELAB with an interest in medical transducers are making units to 10 MHz.) The group has designed and built a sub-bottom profiling sonar for offshore applications, an echosounder and other special purpose units. ELAB purchases ceramic generally from Channel Industries, Vernitron (British), or Ferroperm (Danish) preformed, polled and silvered.

One program expected to begin shortly is the development of an offshore gas-leak detection system.

Another large scale anticipated program is to begin in 1986 and to run for at least three years involving the development of offshore oil rig telemetry and acoustic control systems.

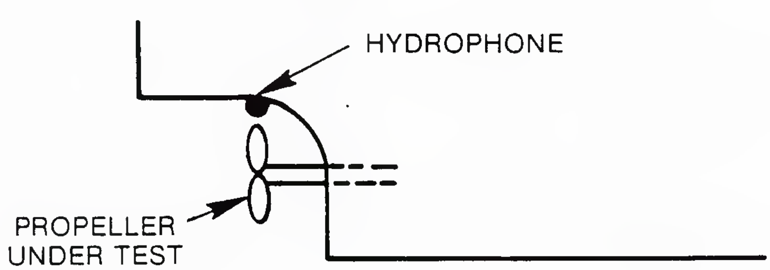


Figure 3-17. Hydrophone Location for Propeller Cavitation/Noise Measurements

Narrative Description (Cont'd):

A well known underwater communication problem is concerned with interference due to multipath interference. ELAB is undertaking a study of possible means to mitigate such interference. This is expected to utilize real-time processors capable of cancelling reflections which constrain the bit-rate.

ELAB does not own a ship and the SINTEF Group has only one 30-ft./9.1-m. vessel. This boat is in the Cybernetics Group and is very well equipped electronically and in terms of computers. However, larger seagoing vessels are as often chartered as needed.

Underwater acoustic experimental facilities include an acoustic test/calibration tank (Figure 3-18) that measures 9.8 x 6.6 x 6.6 ft. deep/3 x 2 x 2 x 2 m. deep. The tank is equipped with two movable carriages. Located in the tank room is all the necessary peripheral equipment including:

- Brüel & Kjaer Turntable (Rotator) Type 3922
- Brüel & Kjaer Graphic Recorder Type 2307 (for rectilinear or polar plotting)
- Dranetz Gating System with Digital Tone Burst Timing Generator Series 206
- Dranetz Sampling Log Voltmeter Series 220
- Brüel & Kjaer Gating System Type 4440

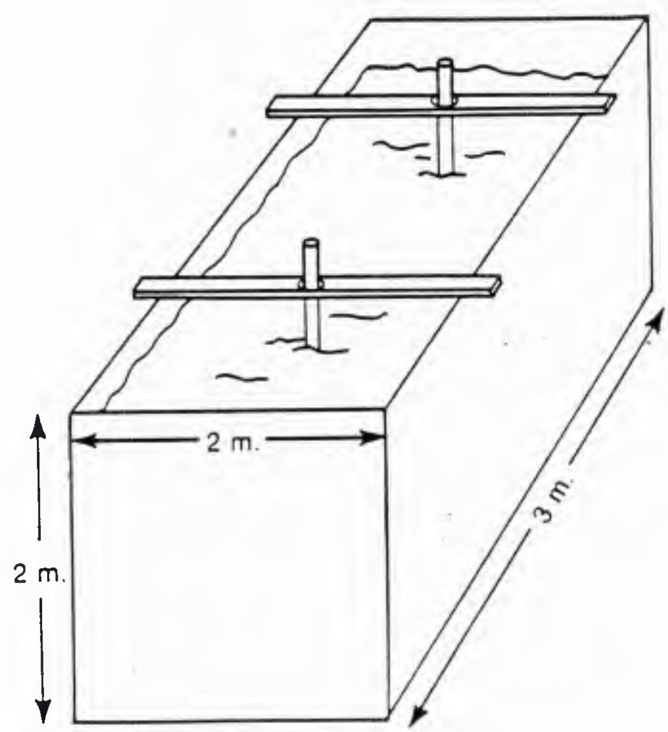


Figure 3-18. ELAB Acoustic Test/Calibration Tank

Narrative Description (Cont'd):

Reference hydrophones (standards) include:

ITC 1089C reciprocal element
Brüel & Kjaer Type 8100 (reciprocal element)
Brüel & Kjaer Type 8103 (small, high frequency element, also reciprocal)
Brüel & Kjaer Type 8101 (with preamplifier)

Power amplifiers include:

Instrument, Inc., 500 Hz-170 kHz, 2 kW pulsed
Instrument, Inc., 10 kHz-500 kHz, 1 kW pulsed
Amplifier Research Model 100A15, 100 Watt
ENI (RF Power Amplifier), 20 kHz-10 MHz, Model 240L

Also available, for recording purposes, is a 4-channel, 1/4 in./6.4 mm. RACAL Magnetic Tape Recorder, with 1500 ft./457 m. reels. Direct record maximum frequency is 300 kHz. FM record maximum frequency is 60 kHz.

The principal digital computing facility in the Underwater Acoustics Group is an HP 1000F with common peripheral units, for general use and field experiments. This unit currently includes a 20 kHz sampling frequency A/D converter, and the data acquisition/recording capacity is soon to be extended. A Compaq data acquisition and signal processing system is available for laboratory use and field experiments.

The major ELAB spectrum analysis capability lies in software for use on VAX computers, HP 1000F computers, and others. In particular, ELAB utilizes the SIG and ILS software systems, which are data reduction/processing utility packages with graphic routines. In addition, ELAB has produced another related software package, PSIM, designed to meet their specific needs in this area.

Date of this Summary
12 August 1985

Facility Name: Norwegian Marine Technology Research Institute A/S

Location: In east side of Trondheim, Norway, approximately 1.5 mi./2.5 km. southeast of the city center.

Cognizant Organization: SINTEF

Facility Functional Name: MARINTEK Ocean Laboratories

Major User(s): Korean shipbuilders, Norwegian shipyards, oil companies

Technical Areas Supported: Ship performance, flow dynamics, propulsion, offshore structures, marine systems

Unique Features: Large cavitation tunnel, large towing tank, an ocean basin laboratory with two independent wave generating systems

Significant Equipment Available: Two cavitation tunnels, an 852-ft./260-m. long towing tank which can be divided into two tanks of lengths 574 ft./175 m. and 278 ft./85 m., ocean basin laboratory with adjustable water depth as well as the two wave generating systems, four HP 1000 computers, approximately 1000 bronze test propellers

Local Environment: On a quiet street with some automotive traffic, in a generally quiet area of Trondheim, approximately 1.5 mi./2.5 km. from the city center

Future Plans for Facility: New workshop for model production. Underwater instrumentation/model tests with underwater vehicles (both free running and maneuverable). Hope to become more involved with submarine R&D for both civil companies and for navies of all countries.

Facility Mailing Address: MARINTEK
Haakon Haakonsonsgt, 34
P.O. Box 4125 Valentinlyst
N-7001 Trondheim
Norway

Local Contacts: Mr. Kjell Holden, Manager, Ship Performance and Flow Dynamics
Mr. Per Werenskiold, Manager, Hydrodynamic Laboratories
Tel: Int. Oper. + 47 7 59 5500 and 47 7 59 5946

Contact for Access/Scheduling: Mr. Werenskiold or Mr. Holden, as above

Narrative Description: MARINTEK is another member laboratory of the SINTEF Group in Trondheim (see description of the SINTEF organization included in the entry for IKU).

MARINTEK was formed in early 1985 by the marriage of two earlier laboratories, NSFI and SHL. (SHL was the Ship and Ocean Laboratory of the former Norwegian Hydrodynamics Laboratories.)

Narrative Description (Cont'd):

MARINTEK employs 260 people at the facility.

The total income expected for 1985 was 130 million Norwegian kroner (which, at an exchange rate of 8.2 kr/dollar at the time of my visit, translated to approximately $12.2 M).

Twenty percent of total income is from the Norwegian Government (i.e., 25 million kroner), which is used mainly for new equipment and for new initiatives in the oil fields.

The MARINTEK organization is shown in Figure 3-19.

Except in the areas of propeller noise, thruster noise and cavitation, MARINTEK is not involved in underwater acoustics measurements. Nevertheless, the available facilities are extensive and the company is amenable to undertaking work in that area.

The large cavitation tunnel was built in 1967 and still ranks as one of the largest in existence. The facility, shown in Figure 3-20, is used almost entirely for propeller research.

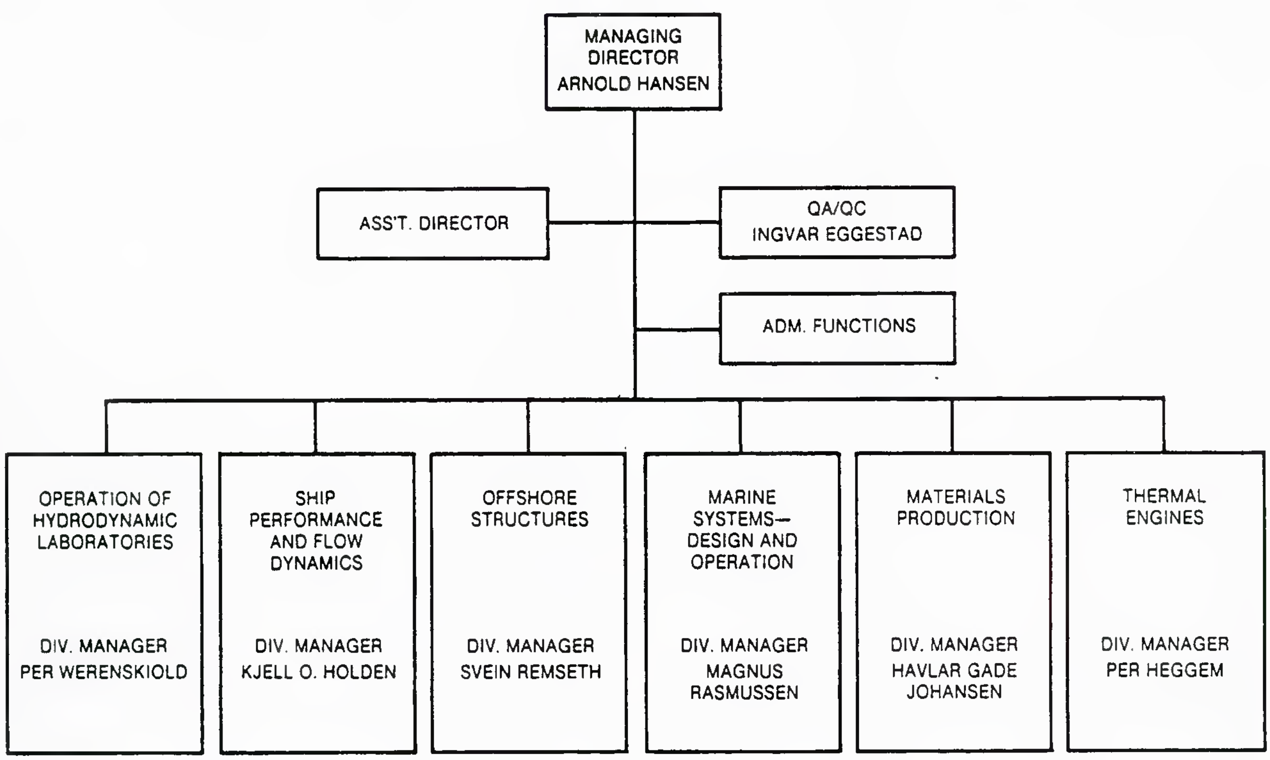


Figure 3-19. MARINTEK Organization

Narrative Description (Cont'd):

Cavitation tunnel characteristics:

- Test Section Diameter -- 3.94 ft./1.2 m.
- Test Section Length -- 6.82 ft./2.08 m.
- Maximum Water Velocity -- 35 knots (18 m./s.)
- Maximum Propeller RPM -- 3000

The system is 1197 ft./365 m. long and 213 ft./65 m. wide.

The stated maximum velocity of 18 m./s. is for the situation where the test section is empty. In actual test conditions, the tunnel is generally operated at speeds of 4 m./s. or 8 or 9 m./s. at the most. (That is, a realistic maximum speed under test conditions would be approximately 17.5 knots).

The original 16.4-ft./5-m. deep towing tank at MARINTEK was built in the 1930's, and the deeper extension was added in 1979. There is then a section 18.4 ft./5.6 m. deep and 574 ft./175 m. long and a section 32.8 ft./10 m. deep and 279 ft./85 m. long. The deep end is used mainly for propulsion resistance measurements, while the shallow end is largely devoted to traditional ship studies.

The total length is 853 ft./260 m. and the tank can be used either as one long tank or as two shorter tanks. The width of the towing tank is 34.5 ft./10.5 m. for both the shallow and deep sections.

A major part of the MARINTEK effort is the evaluation of ship and propeller performance, and the towing tank is a key facility in this area. Figure 3-21 is a photograph of a ship model under test in the towing tank.

The carriage can move at speeds up to 12 knots (6 m./s.) and can support loads up to 20 US tons./17.9 British tons.

Two HP 1000 computers are used in conjunction with the towing tank. One is situated on the towing carriage and the other is located on "shore" at the deep end of the tank.

The third major facility at MARINTEK is the ocean laboratory, opened in 1980 and sometimes referred to as the Ocean Basin. The Basin measures 262 x 164 ft./80 x 50 m. and is variable in depth from 0-32.8 ft./0-10 m.

The depth variability is particularly useful when constructing scale models, permitting considerable freedom in selecting the scale to be used.

Although it is not routine, the Basin is on occasion used for acoustic measurements. Propulsion noise measurements have been made by mounting a B&K Type 8100 hydrophone on a model afterbody. Thruster noise directivity measurements were made by placing the thruster in the center of a circle of 43 of the same B&K hydrophones.

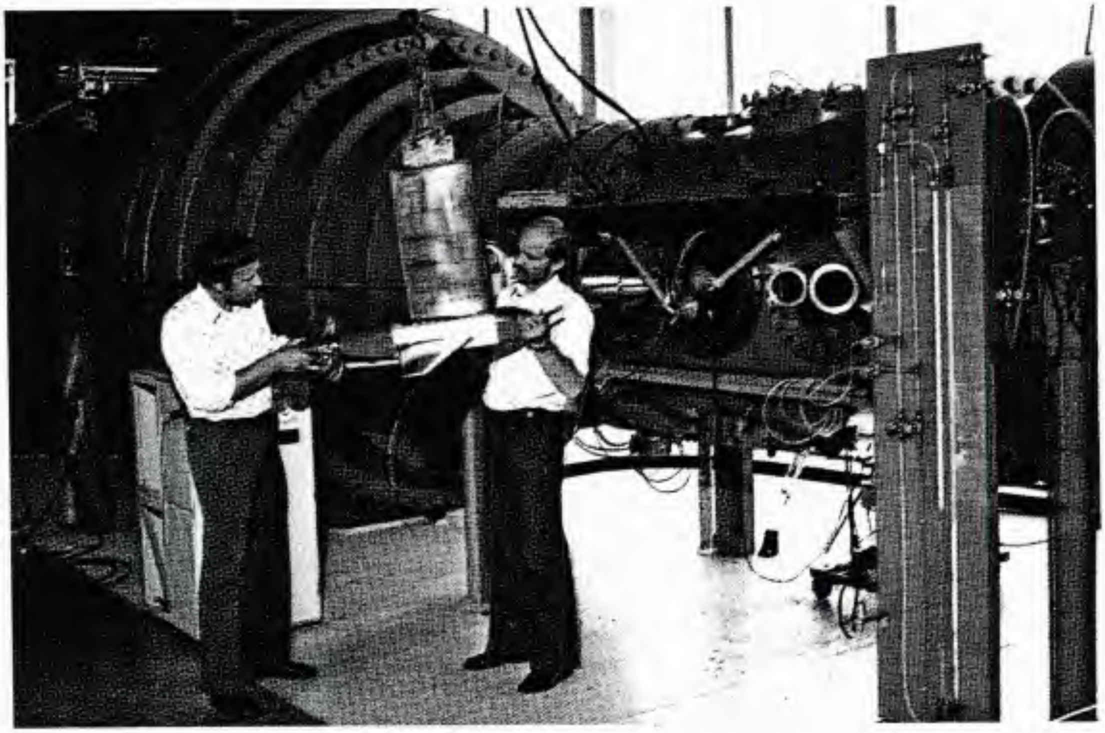


Figure 3-20. Large Cavitation Tunnel

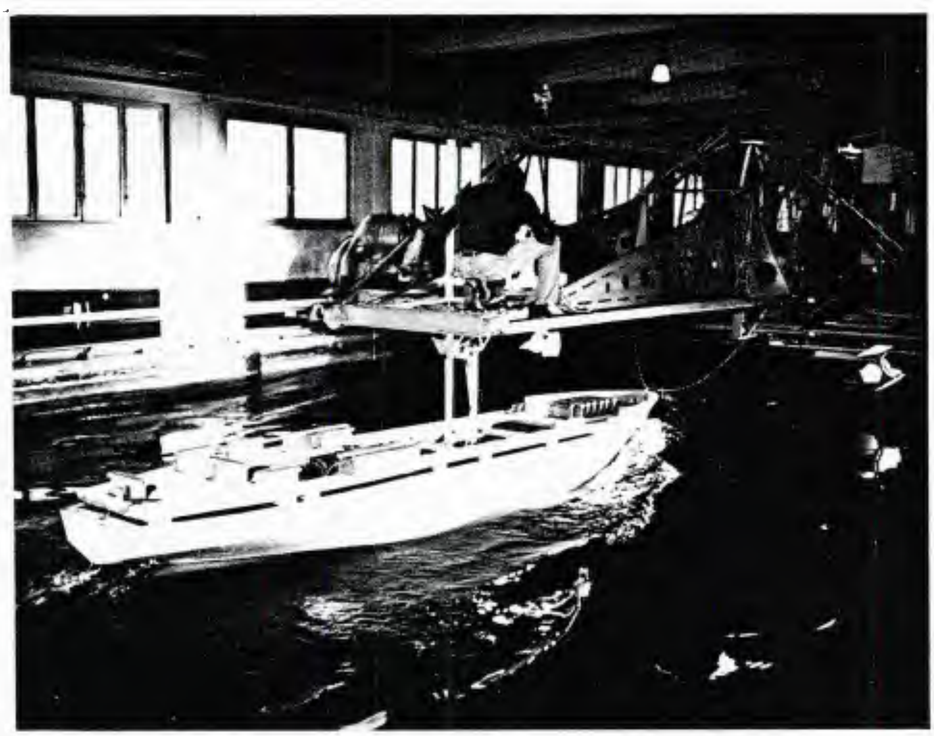


Figure 3-21. Ship Model in the Towing Tank

Narrative Description (Cont'd):

The attractiveness of the Basin to shippers, to shipbuilders and to the petroleum industry lies in the capability to provide excellent scaled environmental simulations including wind, waves and currents for ship studies and also for fixed and floating offshore structures.

The Basin is fitted with one long hinged double-flap wave generator across the short 164-ft./50-m. end, hydraulically driven, capable of wave heights of 3 ft./0.9 m. and periods as low as 0.8 s. Wave spectra may be computer generated or taken from wave recordings. A scaled "beach," acting as a wave absorber, runs across the far end of the Basin. A second wave generator is installed along one side of the Basin, consisting of 144 electrically driven, individually computer-controlled flaps. This second generator can produce waves up to 1.3 ft./0.4 m. and periods as low as 0.6 s. The combination of the two wave generators allows the simulation of multidirectional seas.

Pumps for generating underwater currents can produce maximum currents of 0.35 knots/17-18 cm./s., which is the equivalent of 3.5 knots full scale. It is possible to generate currents in all four major directions in the Basin.

A photo-optical model position locating system was devised for the Basin which involves the installation of infra-red light-emitting diodes on the model, and the model position is subsequently recorded by cameras along the side of the Basin. This system provides accuracies in the horizontal of ±0.02 in./0.5 mm. and ±0.01 in./0.25 mm. in the vertical.

There are 75 radio data channels available from the model to the HP 1000 computer and, when necessary, wires can be added.

Wind effects are simulated by fans installed on the models and by large fans mounted on the "shore."

Two uses of the ocean laboratory are shown in Figures 3-22 and 3-23.

The model guyed structure shown in Figure 3-23 is a 1:50 scale model. In the subsequent tests, the steel floor was lowered to a depth of 23 ft./7 m., corresponding to an ocean depth of 1150 ft./350 m.

Of the two HP 1000 computers dedicated to the Ocean Basin, one is used for running and controlling operations in the Basin and for making spectral analyses and other quick-look data examinations. The second HP 1000 is used for more complete data reduction and processing following the completed test.

A third computer is the HP 21 dedicated to driving the 144 individually controlled wave generator flaps.

Figure 3-22. Ship Model Testing in Simulated High Seas

Figure 3-23. Test Set-Up of Guyed Deep Water Platform

Date of this Summary
16 August 1985

Facility Name: Forsvarets Forskningsinstitutt Avdeling for Undervannsforsvar (FFIU) Defense Research Establishment, Division for Underwater Defense)

Location: On Karljohansvern, at the old Norwegian Naval Base in Horten, Norway. The Navy buildings are in the northeast part of Horten, on a promontory known as Karljohansvern which projects into the Oslo Fjord and which helps to form the Inner Harbour at Horten.

Cognizant Organization: Ministry of Defense

Facility Functional Name: Norwegian Defense Research Establishment (NDRE) or Norwegian Defense Research Laboratory (NDRL)

Major User(s): Norwegian Navy, SIMRAD Subsea

Technical Areas Supported: Transducer development, acoustic propagation, and military oceanography

Unique Features: Ready access to deep water (650 ft./200 m.); Calibration/ Measurement Barge moored in 65 ft./20 m. water depth; or can be brought in to pier

Significant Equipment Available: R/V H.U. SVERDRUP, equipment and crew; transducer laboratory, well-equipped; Calibration/Measurement Barge, movable, used at pier or moored out, fully instrumented; and pressure vessels

Local Environment: Very quiet; offices and laboratories are in a Navy building on the old Navy Base on Karljohansvern. Outside facilities are on the shore of the Inner Harbour and on the north shore of Östöen (an island) in the Oslo Fjord. The Inner Harbour freezes in the winter which prohibits operation in the harbor during that period.

Future Plans for Facility: It is planned to convert the Calibration Barge instrumentation to a totally digital computer-aided calibration system, probably in 1986.

Facility Mailing Address: Norwegian Defense Research Establishment
Division for Underwater Defense
P.O. Box 115
N-3191 Horten
Norway

Local Contacts: Mr. Jarl Johnsen, Head, Division for Underwater Research
Mr. Tor Knudsen, Chief Scientist
Mr. Erling Kjellsby, Transducers
Tel: Int. Oper. + 47 + 33 42 081

Contact for Access/Scheduling: Mr. Johnsen, Mr. Knudsen, as indicated above

Related Information Sources:
Coastal Chart No. 3, 1:50,000
Harbor Chart No. 486, 1:10,000
from Norges Sjøkartverk, Stavanger, Norway
Also: NDRE Internal Report U-232, dtd 31 Jan 1969

Narrative Description: The NDRE Division for Underwater Defense is located in Karljohansvern in Horten, about 58 mi./93 km. by road south of Oslo on the western side of the Oslo Fjord.

Horten can be reached by automobile in about 90 minutes on the E18 road from Oslo. Trains leave the Oslo west railway station several times a day, and passengers must transfer to a connecting bus in Skoppum. (Train/bus travel time is less than 2 hours.)

NDRE is a civilian institute directly responsible to the Ministry of Defense. Established in 1946, NDRE today has approximately 500 employees of whom 180 hold scientific/technical degrees. The main part of NDRE, including approximately 440 people, is located in Kjeller, about 12.5 mi./20 km. northeast of Oslo. The NDRE Division for Underwater Defense in Horten has altogether approximately 60 people, including the crew for the research vessel. The organization of NDRE is shown in Figure 3-24.

Certainly one of the most valuable facilities at the NDRE Division for Underwater Warfare is the research vessel "H.U. SVERDRUP" seen in Figure 3-25. This 400 US-ton/357-British ton vessel has a trawler type hull but was built as a research vessel in 1960.

The ship has a crew of nine and is used generally for underwater acoustic measurements and for military oceanography. Most operations with this vessel are in the Norwegian Fjords and in the Barents Sea, but it has operated in all areas of the North Atlantic.

The ship dimensions are listed below:

Length Overall	127 ft. 8 in./38.9 m.
Beam	24 ft. 11 in./7.6 m.
Draft	12 ft. 11 in./3.95 m.
Displacement (fully loaded)	400 US tons/357 British tons

Some of the details of the vessel can be seen in Figure 3-26. The ship is diesel-driven with a 600 horsepower diesel engine manufactured by Wichmann Motorfabrikk.

The vessel has three diesel generators onboard producing 220 V, 50 Hz:

1 x 55 kVA
2 x 37 kVA

The following power selections are available:

220 V, 50 Hz/220 VDC, 5 kW
220 V, 50 Hz/115 V, 400 Hz, 3 Ø, 7 kVA

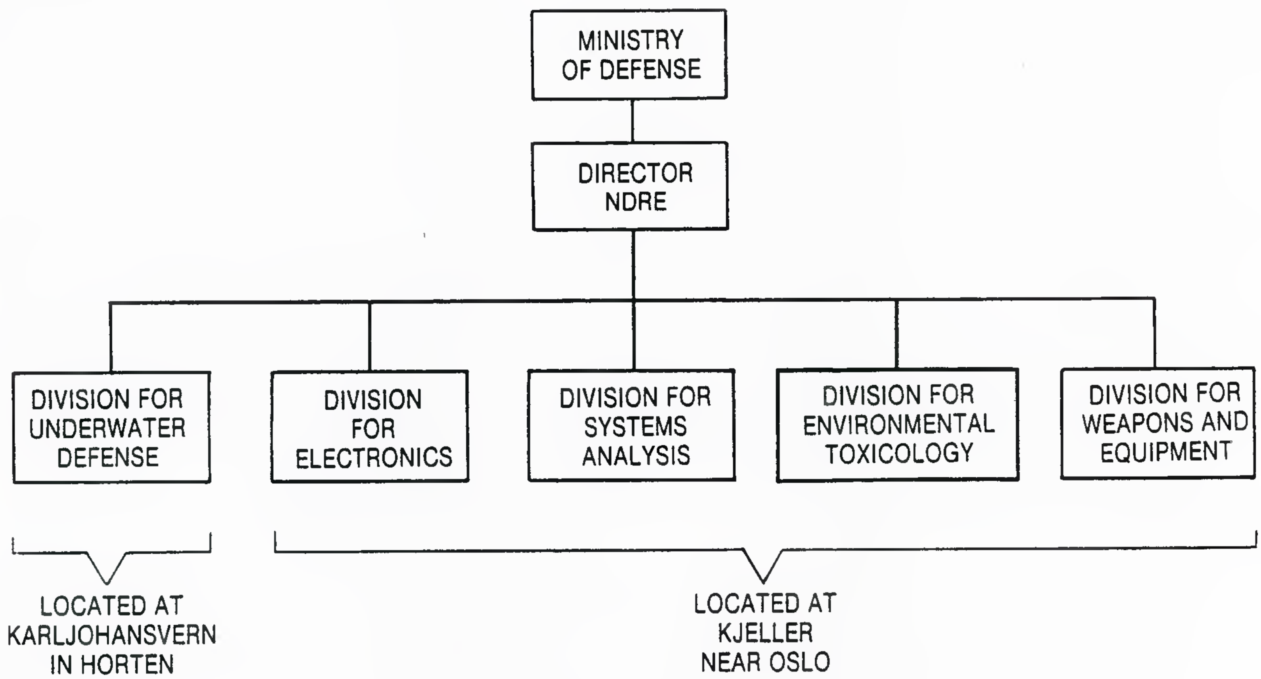


Figure 3-24. NDRE Organization

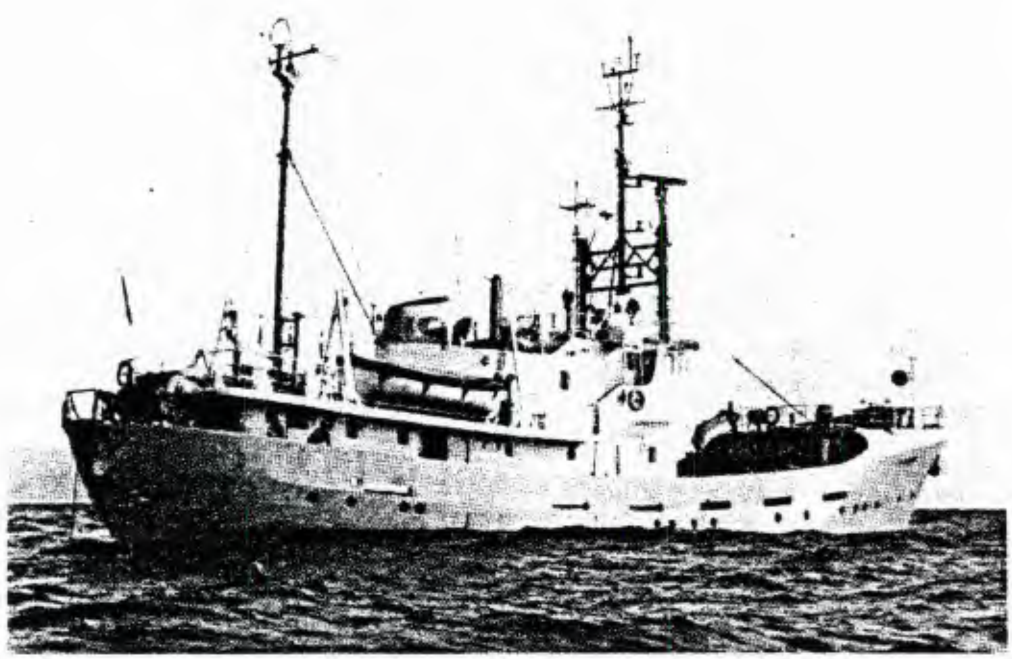


Figure 3-25. R/V H.U. SVERDRUP

Narrative Description (Cont'd):

220 V, 50 Hz/24 VDC, 3.6 kW
220 V, 50 Hz/24 VDC
24 VDC/220 V, 50 Hz, 1 kW
220 V, 50 Hz/115 V, 50 Hz, 5 kVA (Transformer)
24 VDC, 800 Ampere hours (Main Batteries)

The vessel is well supplied with modern radio communications equipment.

Permanently installed navigational equipment includes two radar systems, Kelvin-Hughes 1600 10 kW and a Terma type Scanter. Navigators are Decca type Mk 21 and a Decca Loran C type DL 91. A satellite navigator is carried, a Magnavox type 902-2. The above navigational gear is often augmented by short term lease of DECCA-HIFIX equipment when precision navigation is required (generally when bottom mapping in the Fjords).

Since precision bathymetry is an important part of the program at NDRE, a number of echosounders are installed on SVERDRUP.

1 SIMRAD Basslodd, 0-600 M (38 kHz, on bridge for navigation)
1 SIMRAD Ekkolodd, 0-650 M (38 kHz, on bridge for navigation)
1 SIMRAD Sonar, 0-1500 M (30 kHz, in laboratory)
1 SIMRAD Scientific Sounder EK 12 (12 kHz, stabilized, in laboratory)
1 SIMRAD Ekkolodd EK 50 (50 kHz, stabilized, in laboratory)

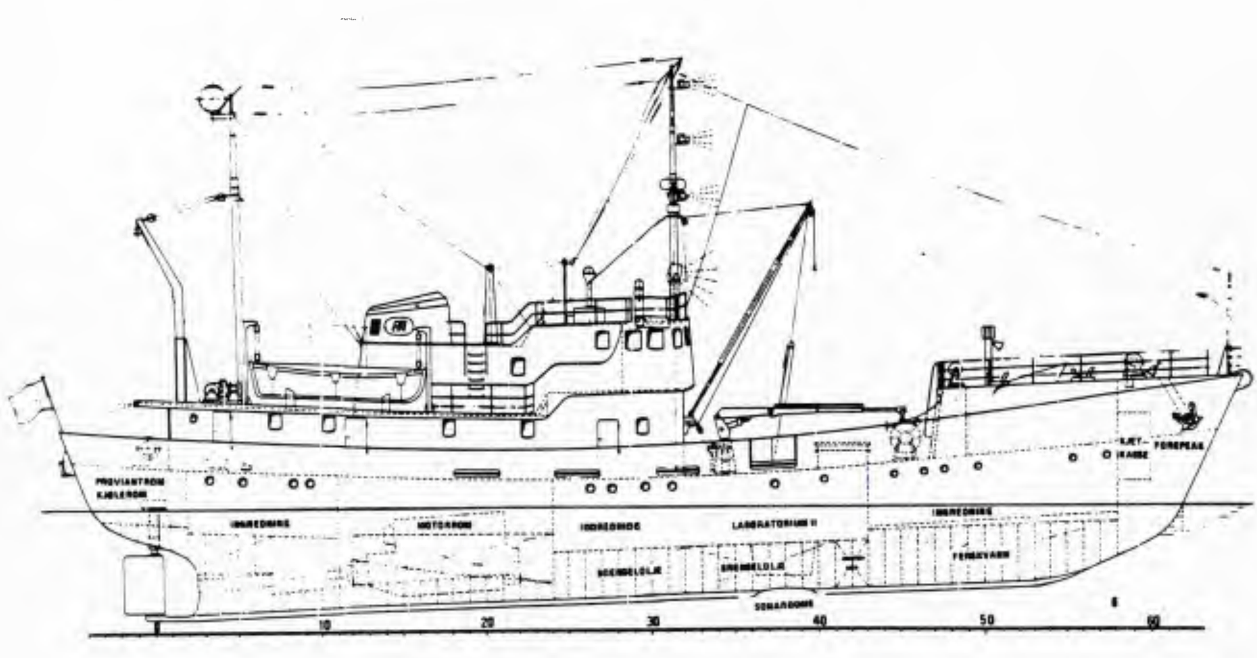


Figure 3-26. H.U. SVERDRUP Details

Narrative Description (Cont'd):

A Nord-10 digital computer, also permanently installed, is used primarily as a data logger and continuously accepts information from:

Decca Navigator
Decca Loran C
Navigator MNS 2000
Gyrocompass
Pit Log
Anemometer

H.U. SVERDRUP is well equipped in terms of cranes, davits, winches and other deck gear and a workboat is carried for over the side operations. A deployable towed sonar, designed and built at NDRE and composed of tonpilz elements operating at 8 and 14 kHz, is carried on the fantail.

The Calibration Barge at NDRE Horten is either tied up at the shore or moored out approximately 0.6 mi./1 km. from the shore in the Inner Harbor, 820 ft./250 m. off East Island in 66 ft./20 m. of water.

The Inner Harbour freezes in winter, so the Barge is usually brought in to shore in December and taken out again in March or April. The Barge is used 50 to 100 days per year during the warm weather months.

NDRE has an 165-ft./50-m. wooden pier on the Inner Harbour with a small pier house. In the winter months, the Calibration Barge is secured alongside this pier in addition to a skiff and a 22-ft./6.7-m. power boat. When the Barge is moored out in the harbor, access is by means of the power boat, which has a forward weather cabin and is outfitted with a 25 HP diesel and a hydraulically operated stern winch used for raising hydrophones, anchors, etc., from bottom depths up to 650 ft./200 m.

The Calibration Barge mooring in the Inner Harbour is indicated by the cross (#1) on Figure 3-27. The bottom is soft mud in this area and the Barge is held in position by concrete clumps and heavy chain off each of the four corners of the Barge.

Cable power to the moored Barge provides 240 volts AC, 3 Ø, 50 Hz, 3 kW.

An internal well in the Barge measures 19.7 x 8.2 ft./6 x 2.5 m. and is provided with two shafts. The larger shaft is fixed to the end wall of the well and can be raised and lowered to a depth of 13 ft./4 m. and can be rotated but is otherwise fixed in position. It can support 1100 lb./500 kg. and is concentric in construction with the outer shaft fixed and the inner shaft rotatable.

The lighter shaft is mounted on a movable carriage and can move laterally across the length of the carriage as well. This second shaft can support 220 lb./100 kg. and does not rotate. It is hand operated and the entire shaft can be lifted up by an overhead hoist.

The Barge is used by NDRE only for calibration purposes, but it has been made available to SIMRAD Subsea and other users for propagation tests, and miscellaneous equipment tests.

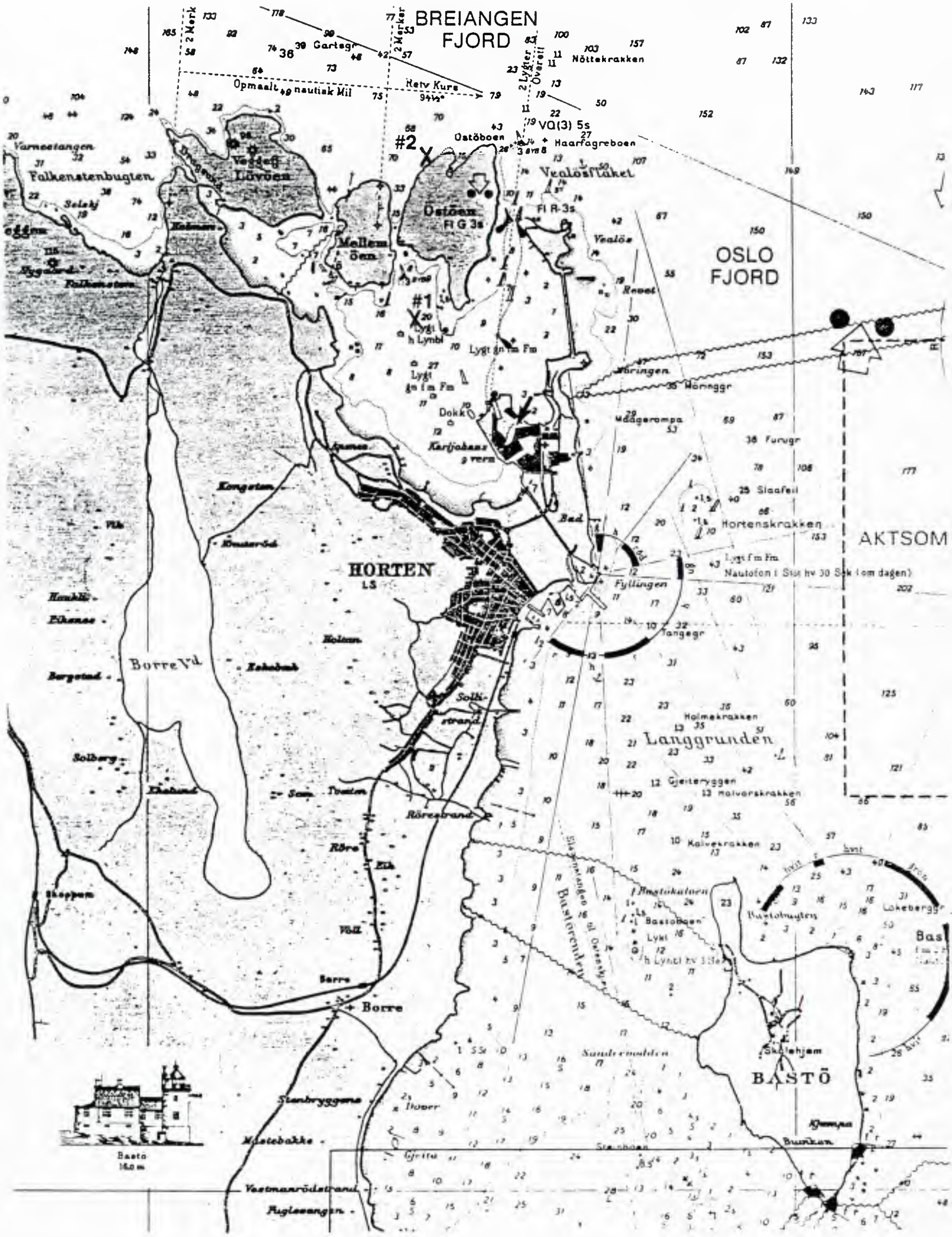


Figure 3-27. Inner Harbor at Horten with Barge Mooring

Narrative Description (Cont'd):

NDRE uses the Brüel & Kjaer Type 8104 (reciprocal) hydrophone as a standard hydrophone and a J-9 as a reference source.

Reciprocity checks of the standards are made at odd intervals at a 32.8-ft./10-m. depth, using a triangular jig constructed in-house for this purpose.

The signals used for the calibrations are generally CW sine wave signals with a 10% frequency warble (about 16 Hz wide).

Pulses are not normally used. Measurements are usually at lower frequencies, below 20 kHz. Rarely are PRN or other noise transmissions used.

The Barge measures 49 x 20 ft./15 x 6 m. and is provided with a 1100-lb./500-kg. monorail and traveling hoist which runs over the center of the well and extends 3.3 ft./1 m. beyond the end of the Barge for ease of loading and unloading.

Power amplifiers on the Barge are a Brüel & Kjaer Type 2713 (100 VA) and a Philips 100-Watt Amplifier.

In addition to the J-9 reference source, other low frequency sources include a Harris Tophat Scroll and an in-house constructed double-ended cylinder terminated in two 10 watt speakers. (This last unit requires air compensation and must be charged prior to each use.) The frequency range is from 50 to 400 Hz with an efficiency of about 1%.

Other instrumentation on the Calibration Barge includes:

- Brüel & Kjaer Sine Generator, Type 1023 (to 20 kHz)
- Brüel & Kjaer Beat Frequency Oscillator, Type 1013
- Venner Electronics, Ltd., Digital Counter, Type TSA 6636/2
- Brüel & Kjaer Measuring Amplifier, Type 2636 (with IEEE Bus)
- Brüel & Kjaer Level Recorder, Type 2305 (Rectilinear and polar plots, linear and log potentiometers); above can be driven directly by rotating shaft motor servo repeater (chain drive)
- Two Brüel & Kjaer Electronic Voltmeters, Type 2409 and 2416
- Allison 2ABR Variable Filter
- Philips Monitor Oscilloscope
- Dual Preamplifier (NDRE construction)
- HP Function Generator, Type 3300A/3305A
- Dranetz Complex Impedance Admittance Meter, Model 100B Mod 4 (with Philips X-Y Recorder PM 8120)

Plans in connection with the Calibration Barge for 1986 include the acquisition and installation of a new digital computer-aided calibration system. Staff are currently selecting appropriate instrumentation.

Another facility in the Breiangen Fjord (a west branch off of Oslo Fjord, north of Horten) not much currently used is on the north end of the island of Ostoen. There is a small building on the shore (indicated by the cross (#2) in Figure 3-27, which serves as a cable termination point. A number of Harris Tophat barium titinate hydrophones (type Z-32) are laid directly on the flat bottom in

Narrative Description (Cont'd):

650 ft./200 m. of water. These are low impedance hydrophones (450 nanofarads) and are connected directly across the 1 nmi. of shore cable (no preamplifiers).

The facility was constructed originally to measure the radiated noise of research vessels but no longer receives significant use, so that to utilize the facility, one must bring all instrumentation required. The facility is about 6.3 mi./10 km. north of Horten and is accessible by auto. The trip takes half an hour each way.

The Transducer Development Laboratory is very well equipped and is supported by all the necessary shop services--machine shop, welding facilities, sheet metal shop, carpentry shop, etc.

A wide variety of prototype hydrophones and active sources are constructed here both for the Navy and for use of NDRE. All types of ceramic elements are constructed: cylinders, mosaics, tonpilz generators, etc. but no magnetostrictive elements or other non-ceramic types. (NDRE has built PVDF elements in past years and recently obtained samples from NUSC/NL for further studies.)

Ceramic material is normally purchased from Channel Industries and is preformed, polarized, and silvered. Most of the material purchased is PZT 5400 and 5500.

Molding material for construction of hydrophones, preamplifiers and for splicing is mostly polyurethane (ADIPRENE). Heated vacuum equipment for polyurethane molding both poured and injection molding is available.

Two ovens are used for preheating the polyurethane compounds and for curing the molded products.

Some neoprene vulcanizing is also done in the Laboratory, mostly for cable splicing, however, rather than for hydrophone construction.

Also included in the Transducer Laboratory is a small open tank for making quick look checks of completed elements.

There is a Water Piston Pump Calibrator which is usable from 1 Hz to 36 Hz, which is very rarely used.

A pure air pistonphone is used much more frequently, because it is simpler and much easier to use and because the results are both accurate and repeatable. The only difficulty is that it is a small unit and takes only small hydrophones. Internal dimensions of the vessel are 4.7 in./12 cm. diameter and 13.8 in./35 cm. deep.

As can be seen in Figure 3-28, this chamber is a variant on the classical pistonphone. A hydrophone comparison system is used here rather than the customary absolute measurement which depends on a measured volume/pressure change in the chamber.

Narrative Description (Cont'd):

Two pressure vessels are available at NDRE. The first is located in the machine shop and originated as a torpedo launch tube. This is a relatively large cylindrical vessel with internal dimensions of 1.5 ft./0.45 m. diameter and 13.1 ft./4 m. length. It is capable of pressures equivalent to a 3280 ft./ 1000 m. water depth or about 1450 psi/98.6 bars. There is one large cable gland in the end cover, and the end cover is secured with split rings and sealed with an O-ring seal.

A smaller pressure vessel has an internal diameter of 1 ft./0.3 m. and a length inside of 4.9 ft./1.5 m. The tank itself is designed for pressure equivalent to a water depth of 32,800 ft./10,000 m. or 14,400 psi/979.2 bars, but the pump presently in use is only capable of a maximum pressure equivalent to 8200 ft./ 2500 m. or 3600 psi/244.8 bars. The vessel has three cable connectors through the lid and the lid is secured with split rings and sealed with an O-ring.

Low frequency reciprocity calibrations have been made in this tank down to frequencies as low as 20 Hz with excellent results in good agreement with other calibrations of the same units.

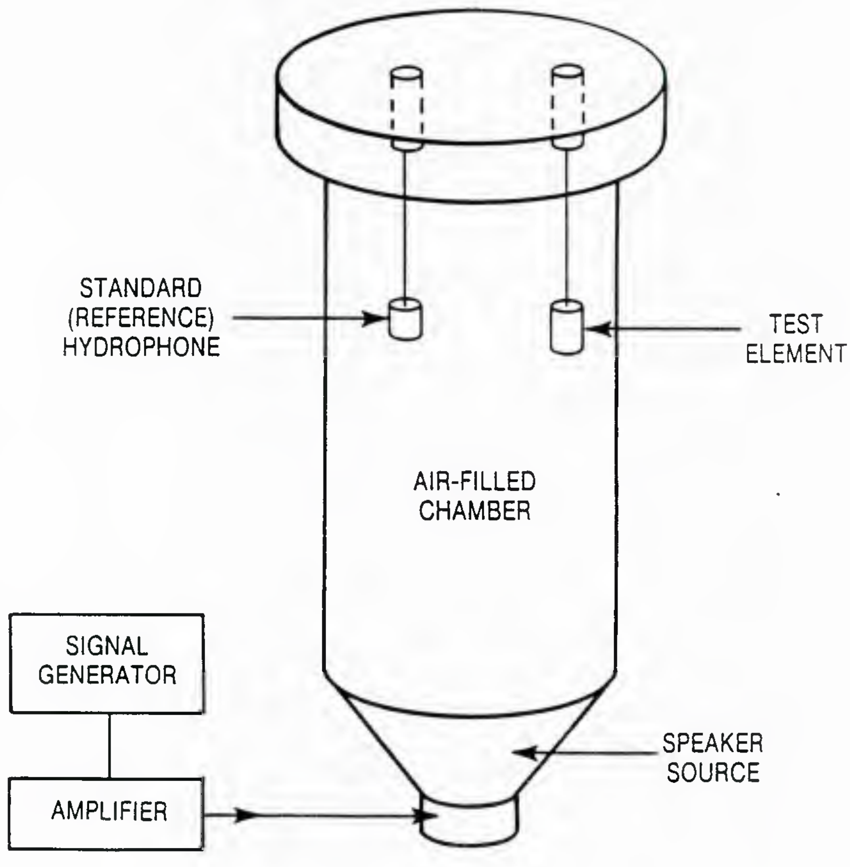


Figure 3-28. Air Pistonphone

Narrative Description (Cont'd):

The Transducer Laboratory is very well instrumented and includes a complete B&K Real Time Frequency Analyzer Set, Type 3347, with control unit, attenuators and other peripherals, as well as all standard bridges, meters, signal generators, oscilloscopes, etc.

Digital Computer requirements are met by a NORD-500.

Date of this Summary
15 August 1985

Facility Name: SIMRAD Subsea A/S

Location: Just off Strandpromenaden and on the inner harbor shore in Horten, Norway. Horten lies on the Oslo Fjord approximately 47 mi./75 km. south of Oslo.

Cognizant Organization: Publicly owned company

Facility Functional Name: SIMRAD Transducer Facilities

Major Customer(s): Oil industry, fishing industry, Norwegian Navy

Technical Areas Supported: Sonar/transducer development

Unique Features: Ready access to quiet, deep water (Oslo Fjord)

Significant Equipment Available: A work boat for R&D support (65 ft./20 m. test boat); a second boat for demonstration and training (94 ft./28.6 m.); in-house R&D test tank, with calibration/measurement electronics. Mobile, floating test barge, 56 x 36 ft./17 x 11 m., for testing of transducers up to 2.75 ton/2500 kg.

Local Environment: Very quiet area in Horten, well away from the city center. On the shore of the inner harbor off Oslo Fjord. Deep water (656 ft./200 m.) accessible in 15 minutes by boat. Inner harbor freezes in winter.

Future Plans for Facility: Replacement of measuring station on pier by a new mobile calibration platform.

Facility Mailing Address: SIMRAD Subsea A/S
Strandpromenaden 50
P.O. Box 111
N-3191 Horten
Norway

Local Contacts: Hans-Jørgen Alker, Technical Director
Trond Helland, Sales Manager, Naval Division
Tel: Int. Oper. + 47 33 44250

Contact for Access/Scheduling: Mr. Alker or Mr. Helland, as above

Narrative Description: SIMRAD Subsea, a publicly owned company, originated as Simonsen Radio Co., and was transformed into SIMRAD in 1970. Since the company stock was first offered to the public in 1982, employees have purchased 15% and 21% is now foreign owned.

SIMRAD employs a staff of 217 at the home offices and main plant in Horten. The entire company consists of about 277 persons--17 in Bergen, 20 in Canada, 10 in Seattle, 3 in Houston, and 10 in Aberdeen; nearly all of those outside Horten represent sales personnel.

Narrative Description (Cont'd):

SIMRAD's gross product is about NOK 210 mill., of which company R&D receives 13%. The R&D effort is located in Horten under the Technical Division and the staff dedicated to that effort is 65 (approximately 30% of the resident staff).

The company is very market-oriented as reflected in the organization. The five major markets identify the five groups into which the company is divided. See Figure 3-29.

SIMRAD Subsea produces a variety of sonars and underwater acoustic systems for the markets mentioned above: offshore petroleum industry, Navy, and the fishing industry.

The acoustic systems for the offshore oil installations are mainly position reference systems, tracking systems and underwater navigation systems operating between 20 and 33 kHz in conjunction with acoustic transponders and/or beacons. Norwegian law requires that in some areas drillers provide backups to the blowout prevention systems in the form of acoustic control systems. SIMRAD Subsea incorporates such a subsystem as a feature in many of their navigation systems, and they provide a portable dunking transducer system for this purpose as well. SIMRAD Subsea also manufactures a 38 kHz acoustic gas leak detection system. In a precision pier approach and docking system operating at 710 kHz, the source transducers may be installed on the vessel for ranging off of the structure to be approached, or they may be installed on the fixed structure with large visual displays providing information to the ship master.

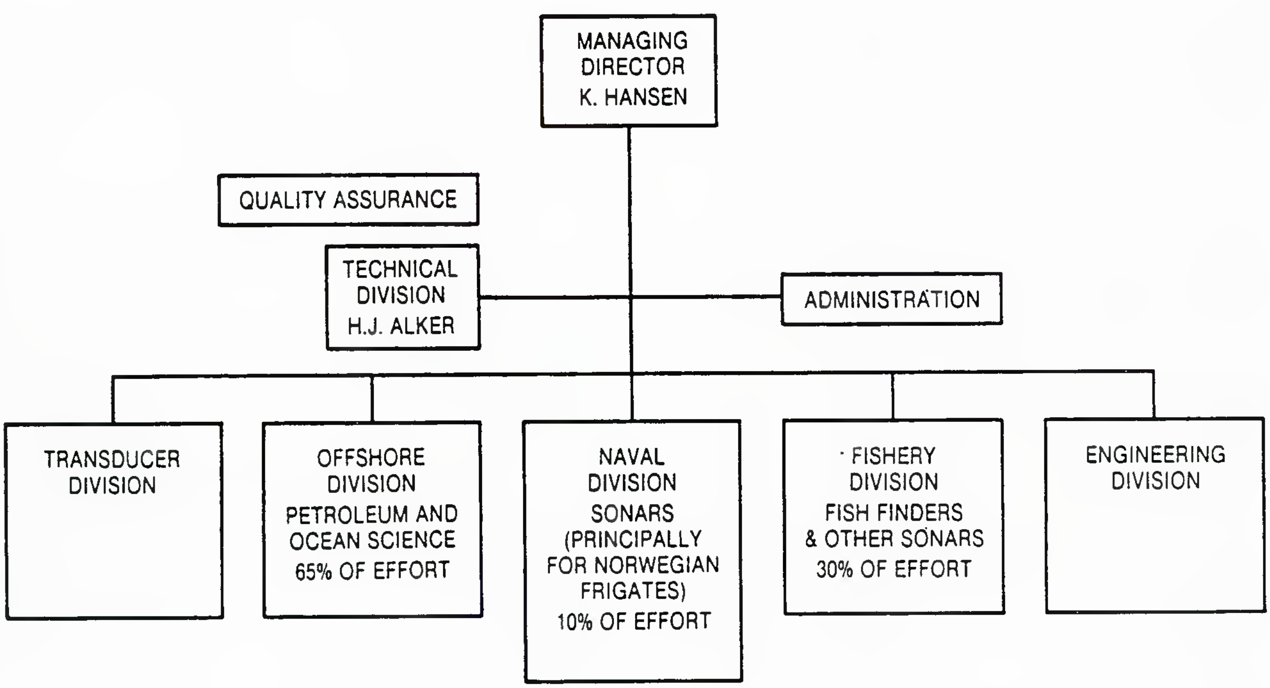


Figure 3-29. SIMRAD Subsea A/S

Narrative Description (Cont'd):

SIMRAD produces a series of echosounders, with a selection of 8 operating frequencies from 12 kHz to 710 kHz and a multibeam wide swath bathymetric mapping system which operates at 95 kHz.

For the fisheries industry, SIMRAD produces a wide variety of high frequency systems for fish location, fish tracking, for school population assessment, trawl net position and motion relative to a school of fish, and towed body echosounder systems. The most favored frequencies for these systems are 12, 38, 49, and 120 kHz.

SIMRAD builds a series of scanning sonars for the Norwegian government, or to be sold to other governments, with fixed or retractable sonar transducer/dome arrangements. The SS-105 is a 14 kHz system installed in the new Norwegian Coast Guard vessels. The SS-304 is a 34 kHz unit with multicolor display, intended for smaller coastal naval vessels. The SS-240 OMNI Sonar with pulsed CW or FM modes and multicolor displays uses 192 elements in a lattice pattern, and is available in a variety of fixed or retractable transducer/dome options. SIMRAD is currently building a variable depth sonar as well, fabricating the transducer and all three electronic stacks while purchasing the towed fish. Other systems and arrays for the Navy include a 256-element hemisphere which operates at 57 kHz, and a 38 kHz echosounder using a GRP fathometer housing (instead of the customary metal casting). Another system produced here is a high frequency (1.0 MHz) dual transducer Doppler speed log.

SIMRAD has excellent transducer construction facilities, including vulcanizing, molding, degreasing, filling and soldering facilities, and normally designs and builds all the transducers used in their sonars, including housings, and designs and performs final assembly and testing of the electronics as well. All the R&D electronic and/or mechanical design at SIMRAD relies on computer aided design and computer aided manufacturing (CAD/CAM) programs. All cabinets and consoles are purchased (generally from local contractors) and all electronic cards are purchased prewired.

Ceramic for the transducers is purchased preformed, polled, and silvered.

A single very large room at SIMRAD is used for electronics assembly, transducer manufacture and for factory testing.

As part of the final factory testing, each transducer element which comes off the production line is given a quick in-water test here. Used solely for such production testing is an unlined tank with non-movable fixtures which measures 7 x 4 x 4 ft./2.2 x 1.2 x 1.2 m.

R&D Facilities:

The R&D acoustic measurement/calibration facilities, which are under the Transducer Division, are more extensive. Included here is a well instrumented calibration tank that measures 16.5 x 13 x 13 ft./5 x 4 x 4 m. (See Figure 3-30.) The tank is not anechoically lined, since that is not necessary at the frequencies and pulse lengths normally used.

R&D Facilities (Cont'd):

The tank is provided with two carriages, both of which are motor driven. The heavy shaft and carriage can support 2200 lb./1000 kg. and the light shaft can support 220 lb./100 kg. All shaft motions are motorized. The heavy shaft can be moved up and down, it can be tilted and it can be rotated. The light shaft is restricted to motions up and down (no training or tilting) and, of course, its carriage can be moved along the length of the tank.

Mounted on the heavy shaft is a motor-driven synchro accurate to about 0.1°.

The tank water is filtered each night and the circulating pump is secured each morning to permit acoustic measurements during the daytime hours.

Measurement signals normally used in the tank are short pulsed sine-wave transmissions with steady-state noise transmissions used infrequently. Routine measurements include receiving sensitivities, transmitting responses, beam patterns, and impedance plots. Array tests are conducted under full load at full power.

A 94-ft./28.6-m. ex-yacht, "SIMPSON ECHO," was put into operation in the spring of 1985 as a workboat dedicated to the R&D program.

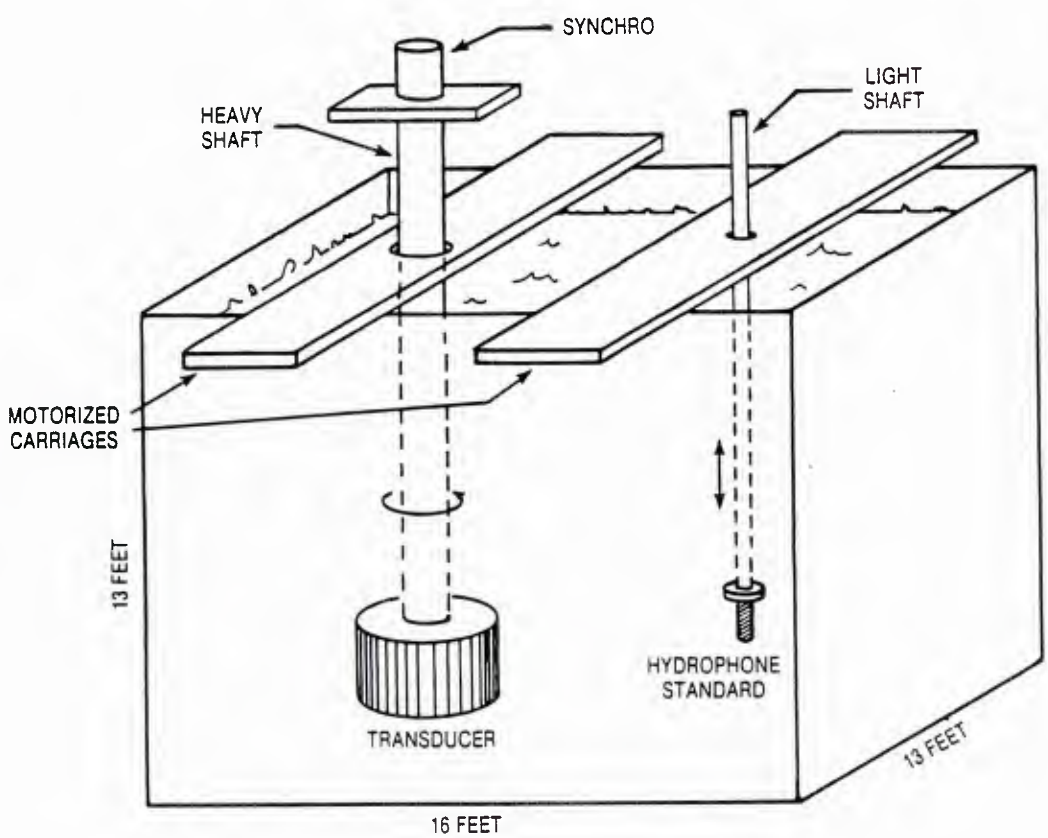


Figure 3-30. SIMRAD R&D Measurement Tank

R&D Facilities (Cont'd):

A second boat, 65 ft./20 m., is outfitted as a system demonstration/training vessel. Onboard systems include:

HPR-309 -- Hydroacoustic Position Reference System
HPR-305 -- As above with a different operator interface
EM-100 -- Multibeam Hydrographic Sounding System
EA-200 -- Echosounder
ES-400 -- Target Strength Analyzer
SM-600 -- Sector Scanning Sonar
SS-240 -- Omni Scanning Sonar

A new mobile measurement platform is moored at the end of a pier near the main building in 20 ft./6 m. of water. It can be readily moved to deeper water, 656 ft./200 m., about 0.6 mi./1 km. away while remaining in sheltered water.

The platform will have cable power (220 V, 3 Ø, 50 Hz) when at the pier and will operate off its own power generator when moored out.

The new platform is about 56 ft./17 m. long and has two transducer mounting shafts. The forward shaft can support 2.75 tons/2500 kg. and the other shaft is used for hydrophone or transducer support.

The platform has an internal 2.5-ton/2273-kg. travelling hoist. All materials and equipment are loaded and removed by a large shore crane.

Date of this Summary
5 June 1985

Facility Name: Meetpost Noordwijk

Location: In the North Sea, 8 mi./12.9 km. west of Scheviningen (on the coast near den Haag)

Cognizant Organization: Rijkwaterstaat (Ministry of Transport)

Facility Functional Name: North Sea Measuring Platform

Major User(s): Ministry of Transport, Ministry of Health, Hollandse Signaalapparaten BV, and the Physics and Electronics Laboratory (FEL-TNO)

Technical Areas Supported: Seawater condition, rainwater contamination, acoustics, and sonar system test and evaluation

Unique Features: Stable platform in the open sea; ready access from shore

Facility Mailing Address: Meetpost Noordwijk
Rijkwaterstaat
Directie Noordzee
Koopmansstraat 1
P.O. Box 5807
2280 Rijswijk (ZH)

Local Contacts: Mr. A.H. Koeman
At above address
Tel: Int. Oper. + 31 70 94 95 00

Contact for Access/Scheduling: Ir. A.H. Koeman, as above

Narrative Description: Weather and schedules precluded a visit to the subject platform.

The platform is located in the North Sea about 8 mi./12.9 km. west of Schevingen (on the coast near den Haag). See Figure 4-1. The Meetpost Noordwijk (literally Measuring Station North District) is reached either by helicopter or by ship.

The helicopter flies daily, Monday through Friday (weather permitting), from Schiphol (East) at the airport south of Amsterdam. The service is operated by KLM and serves all the North Sea platforms in the area (mostly oil companies). The helicopter trip takes about 15 minutes each way and the cost of each one-way trip is 3000 fl (about $885). The helicopter can carry a maximum of 10 passengers (but usually does not), so the cost per passenger could be as low as 300 fl ($90) each way. During the abortive flight on 5 June, there were five passengers.

On 5 June 1985, the helicopter took off from Schiphol (East) at 0715 in considerable mist and overcast. The pilot located the platform on radar but did not have the required 1/2 mile visibility for landing and shortly after returned to the airport.

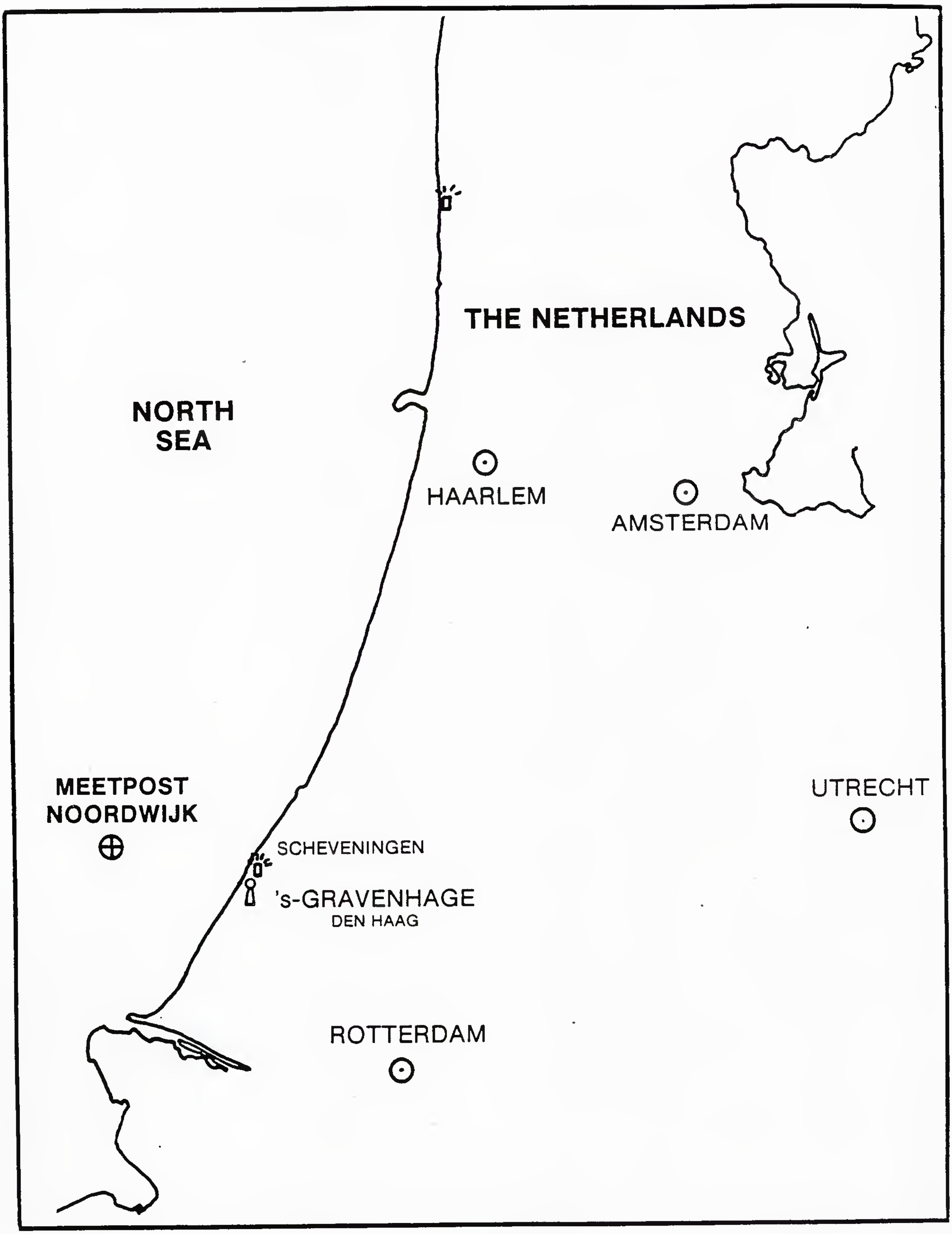


Figure 4-1. Approximate Position of Meetpost Noordwijk

Narrative Description (Cont'd):

Normally, a supply ship visits the platform two or three times per week, especially during times of poor visibility. Unfortunately on 5 June the Ship Master decided that the seas were too high to attempt a ship landing at the platform.

FEL-TNO has used the platform to make measurements of the acoustic effects of air bubbles in the sea.

Hollandse SIGNAALAPPARATEN BV (part of Philips) in Hengelo makes use of the tower for sonar test purposes. [The Netherlands was building two submarines for Taiwan and SIGNAAL was providing the sonars. These sonars were undergoing tests on the platform at the time of the aborted visit.]

It is planned that another visit to the platform be attempted in the future and that this entry be completed at that time.

Date of this Summary
31 May 1985

Facility Name: Physics and Electronics Laboratory (FEL-TNO)

Location: Secluded area on the Oude Waalsdorperweg in the northeast sector of Den Haag

Cognizant Organization: The Physics and Electronics Laboratory (FEL) is under the Defense Research Organization of TNO (Netherlands Organization for Applied Scientific Research).

Facility Functional Name: Acoustics research group of FEL

Major User(s): Netherlands Ministry of Defense; some industrial use

Technical Areas Supported: Transducer and array development, acoustic propagation

Unique Features: A shore-based sonar facility in an area of high density ship traffic, near Hoek van Holland, used for signal processing studies and experiments on displays; calibration/measurement tank acoustically isolated from building at FEL; remote lake facility at Nootdorp

Significant Equipment Available: Anechoic calibration/measurement tank with complete instrumentation, including standard sources and reference hydrophones; steel pressure vessel; fiberglass filament wound pressure vessel; above-mentioned planar array deployed from a jetty; containerized instrumentation set for shipboard use; radio-controlled seagoing sound source raft, "NEREUS"; Nootdorp Lake Measurement Facility (to be reported as a separate entry)

Local Environment: Laboratory area is quiet, with some automobile traffic noise, but calibration tank is isolated from building.

Future Plans for Facility: A new seagoing hydrophone array is planned, similar to vertical line array (VLA), which is called "VLAM" (M for modular); new and faster disc for new HP digital computer; new programs for acoustic signal recording being written

Facility Mailing Address: Physics and Electronics Laboratory TNO (FEL-TNO)
Oude Waalsdorperweg 63
P.O. Box 96864
2509 JG The Hague
Netherlands

Local Contacts: Ir. H.A.J. Rijnja
Ir. J. Verbiest
At above address
Tel: Int. Oper. + 31 70 26 42 21 Ext. 332

Contact for Access/Scheduling: Ir. J.G. Schothorst, as above

Narrative Description: The organization of FEL-TNO, and in particular the position of the Acoustic Research Group in that organization, is shown in Figure 4-2. As indicated, FEL-TNO is a laboratory doing applied physical research for the Defense Department. It exists to support the Navy, the Air Force, and the Army.

FEL, which became the Physics and Electronics Laboratory in December, 1984, was previously identified as the Physics Laboratory (PL) and as the Laboratory for Electronic Development (LEOK). FEL has a staff of approximately 500 people.

FEL is a member institute of TNO, the Netherlands Organization for Applied Scientific Research. TNO currently includes eight research branches. The work is being done in about 50 institutes, representing approximately 5000 people.

A major facility at FEL is the large and well instrumented anechoic calibration/measurement tank. The tank, constructed in 1967, has the general shape of an ellipse but with eight straight sides (Figure 4-3). The maximum dimensions are 28.3 x 32.8 x 26 ft. deep/8.65 x 10 x 8 m. deep. The tank is capable of accepting units to a maximum diameter of 6.5 ft./2 m. and a maximum weight of 5.5 US tons/5000 kg.

The interior dimensions of the tank are actually reduced by 19.7 in./50 cm. at each wall due to the presence of the anechoic lining.

The tank lining is made up of panels 3.3 x 3.3 ft./1 x 1 m., each subdivided into a 9 x 9 matrix. In each element of the matrix a pyramid formed by a stack of cork-elastomer wedges is mounted. (The wedge material is identified as Type B328, manufactured by James Walker, Ltd., Woking, England.)

Measured reflection loss at the tank anechoic lining as a function of frequency is given below.

Frequency (kHz)	Reflection Loss of Lined Walls (dB)
2	6
4	9
8	12
16	15
20	13
40	10

The tank water is chlorinated, filtered, and circulated each night to avoid marine growth and the formation of thermal layers.

The tank is provided with a large trolley and two smaller trolleys. The large trolley is fitted with a removable heavy-duty rotatable shaft with a 5.5-US ton/5000-kg. load limit. The two smaller trolleys are fitted with lighter, non-rotatable shafts, with load limit of 1100 lb./500 kg. each.

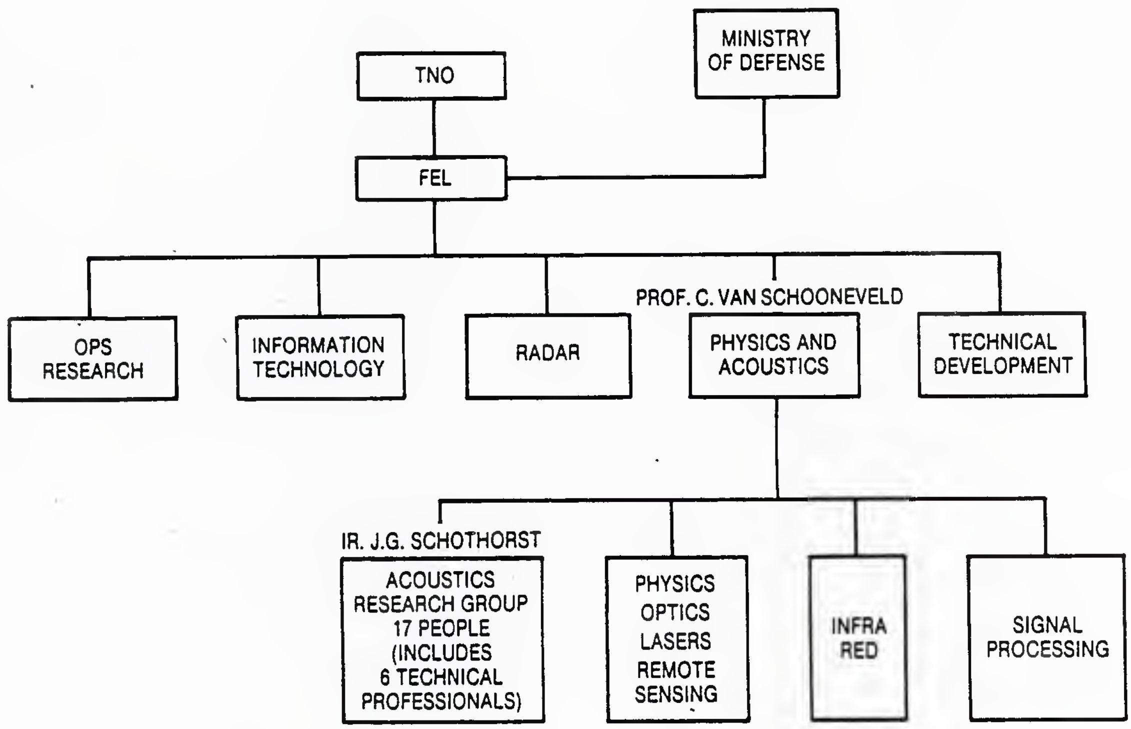


Figure 4-2. Organization of FEL-TNO

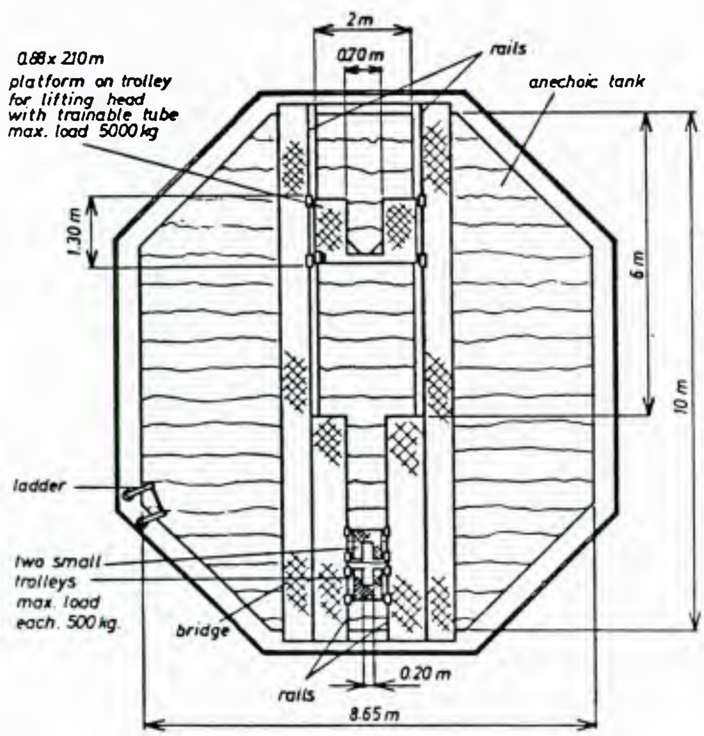


Figure 4-3. FEL Anechoic Calibration Tank

Narrative Description (Cont'd):

The rotator for the large shaft was developed and constructed in the FEL Laboratory. The rotator is used in conjunction with a Brüel & Kjaer Type 2307 Level Recorder with polar plotting capability and with logarithmic potentiometers. The maximum speed of rotation is 360°/3 minutes.

Since the laboratory workshops may produce disturbing noises by ground vibrations, the tank is acoustically isolated from the building and as a consequence is extremely quiet except at near-seismic frequencies.

The minimum reliable frequency for sensitivity measurements and transmitting response is normally considered to be 5 kHz, using pulsed sine wave signals. The minimum frequency for beam patterns is generally 2 kHz, which are also made using pulsed sine-wave signals.

For hydrophones, measurements can be extended to frequencies as low as 20 Hz, transmitting continuous noise and using a hydrophone replacement method. Received signals are processed through one-third octave band filters.

Standard sources include a J-9, a J-11, and EDO 337 (10 kHz - 37 kHz) and a British-made Derritron (Hastings) Hydrosounder good down to 20 Hz.

Standard receivers include an Atlantic Research LC 32 (good up to 12 kHz) and a B&K Type 8100 (good up to 80 kHz). Another B&K hydrophone (Type 8101 with Preamplifier), also good up to 80 kHz, a Clevite CH-1A used at frequencies up to 100 kHz and a B&K 8103 good to 125 kHz. An Atlantic Research LC 10 is flat to 120 kHz and an LC 5 is used from 1 Hz to 600 kHz. (Note: Atlantic Research is now Celesco, Transducer Lane, Canoga Park, California.)

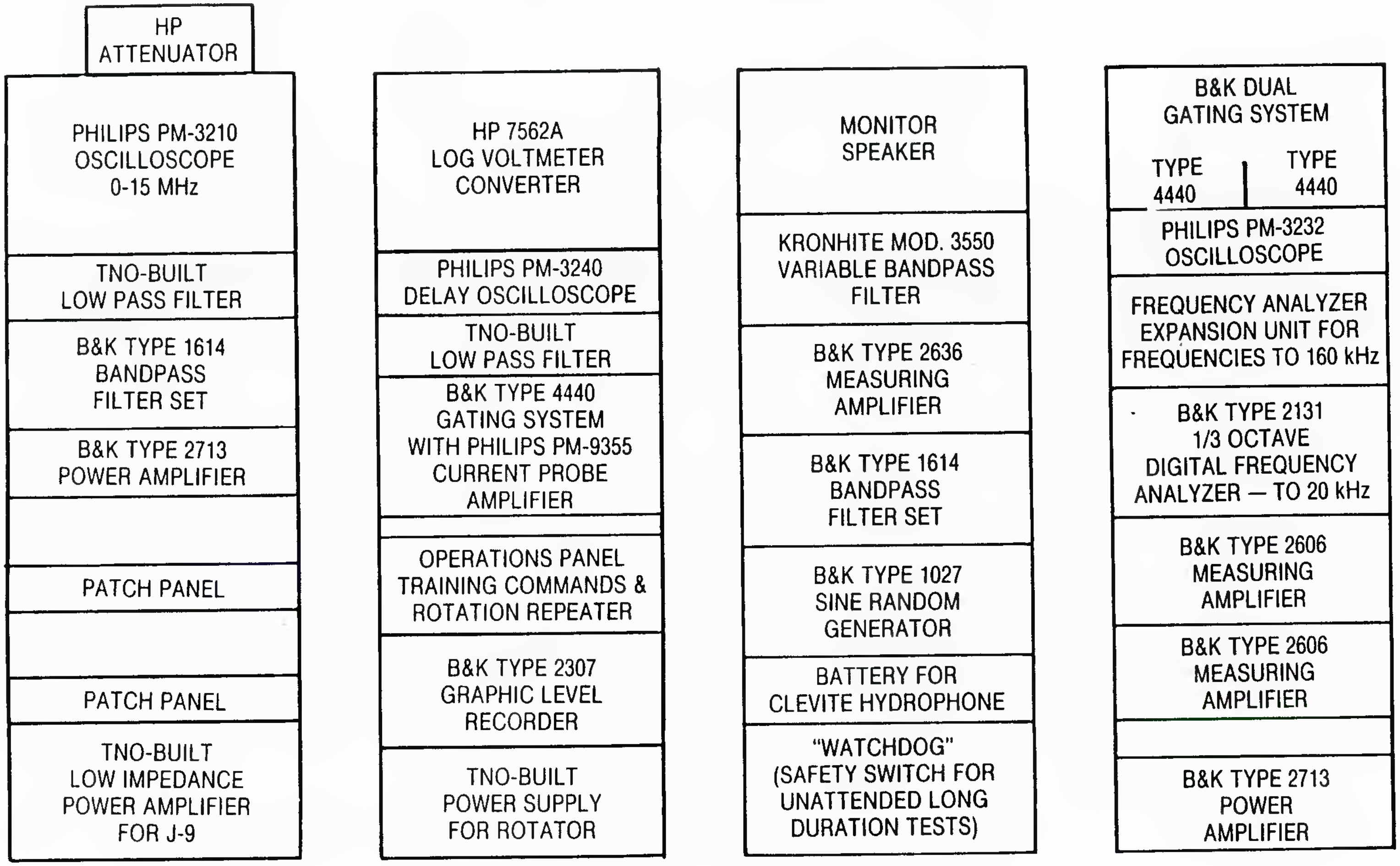
Three-element reciprocity measurements are regularly performed using the J-9 and the J-11 projectors as well as self-reciprocity measurements using only the smaller reciprocal elements.

The set of instrumentation at FEL used with the anechoic calibration tank was recently enclosed in an interior structure to reduce the corrosion rate (switches, etc.) due to the high humidity in the immediate vicinity of the tank.

This set of equipment is shown in Figure 4-4.

A fiberglass filament-wound pressure vessel used at 588 psi/40 bars pressure and which is provided with a 4-bolt flange adapter to the large shaft permits calibration under pressure and the capability of examining hydrophone sensitivity dependence on pressure. The internal dimensions of this pressure vessel are 17.7 in./45 cm. in diameter and 19.6 in./50 cm. in length. The neck diameter is approximately 6 in./15 cm. The vessel is mounted in an inverted position on the tank shaft, so that the hydrophone cable falls below the vessel and out of the acoustic field of interest.

There is in addition a smaller water-filled tank which measures 6.5 x 6.5 x 14.7 ft./2 x 2 x 4.5 m., but which is nowadays rarely used. The tank is not lined and there are no permanent shafts nor other hydrophone/transducer supports.



(INSTRUMENTATION SUBJECT TO FREQUENT CHANGE)

Figure 4-4. Rack Layout for FEL Calibration Tank

Narrative Description (Cont'd):

Other instrumentation used in connection with the calibration tank include:

Phase Measurement Generator -- PMG 390
Vector Impedance Oscilloscope -- TNO-built
Operates from 3 kHz to 300 kHz
with Balantine 5725 B Digital Frequency Counter

Also available within the laboratory is a transportable (on wheels):

2.5 kW Amplifier
Selectable Output Impedance 11 to 2000 Ohms
Frequency Range 500 Hz to 10 kHz

A steel pressure vessel capable of pressures up to 1470 psi/100 bars is in use in the transducer development/construction area. This vessel has an inside diameter of 18 in./46.3 cm. and a length of 28 in./71.3 cm.

A planar array composed of 8 staves of 6 elements each, utilizing as elements the Massa TR61A, provides a single fixed beam. This array is currently not in use but remains available. It has been used for signal processing studies and in experiments in the past concerned with the development of display. The array measures 45 in./115 cm. in length and 35.4 in./90 cm. high, and is driven with a TNO-built power amplifier. The array has been operated from a small laboratory building on a jetty at Hoek van Holland (on the waterway from the North Sea to Rotterdam--a very busy location past which many ships must travel).

Also available at the FEL Laboratory is a noise augmentation unit (BQT) and a towed version (TBQT) which simulates the radiated noise of a submarine.

For at-sea tests, FEL-TNO makes use of a Netherlands Navy Hydrographic vessel (a White Ship), the HNLMS TYDEMAN. This is a ship of 3000 tons displacement, 295 ft./90 m. in length and with a beam of 46 ft./14 m. This vessel has eight cabins with berthing for 15 scientists, as well as offices and laboratory spaces. It has an interior well through which hydrophones and other equipment can be lowered, while the vessel is lying-to. A glassfibre dome can be fitted below the well. Another significant feature of this vessel is that it is configured to accept two instrumentation containers.

FEL has used a container on this vessel for about 10 years, in particular to house the instrumentation for NEREUS (Netherlands Experimental Raft Suspended Electromagnetically Controlled Underwater Sound Source). This is a converted 20-man life raft outfitted to suspend an acoustic source 656 ft./200 m. below the raft. (See Figure 4-5.) The raft is supplied with navigation lights, a fog horn, and a radar reflector.

NEREUS can be used either anchored or free floating. The receiving hydrophones normally used with NEREUS during experiments at sea are suspended from TYDEMAN, either through the well or over the side of the ship.

Narrative Description (Cont'd):

At the time of the visit there was a plan to build a replacement array in the form of VLAM using new hydrophones, with internal preamplifiers, and 4 or 5 modular cable sections to allow a maximum hydrophone depth of 1640 ft./500 m.

This new array was to be ready for Tripartite tests in September 1986 and for MILOC Survey Resolute support in 1987.

At the time of this visit the container was instrumented to evaluate the performance of a Netherlands-built experimental towed array and the instrumentation in the container for that purpose is shown in Figure 4-6. The instrumentation would not be greatly changed for use with the new VLAM array. Note that in Figure 4-6 the panel identified as VESTEL is the control panel for NEREUS.

Other instrumentation normally carried on TYDEMAN but not included in the container consists of:

- Communications Radio
- Wave Height (Wave Rider) Receiver
  - with A/D Converter and Multiplexor and Tape Punch
- Ampex Type 2200 Analog Tape Recorders (Backup)

Located down in the internal well area of TYDEMAN is a relay rack which includes power supplies and preamplifiers for the hydrophones to be lowered through the well, as well as monitoring oscilloscopes, speakers, and intercommunication system.

The NEREUS Raft is described in detail in a 1977 report by Ir. J.G. Schothorst of FEL-TNO.

TYDEMAN is reported in a booklet (in English) published by the Netherlands Hydrographic Office.

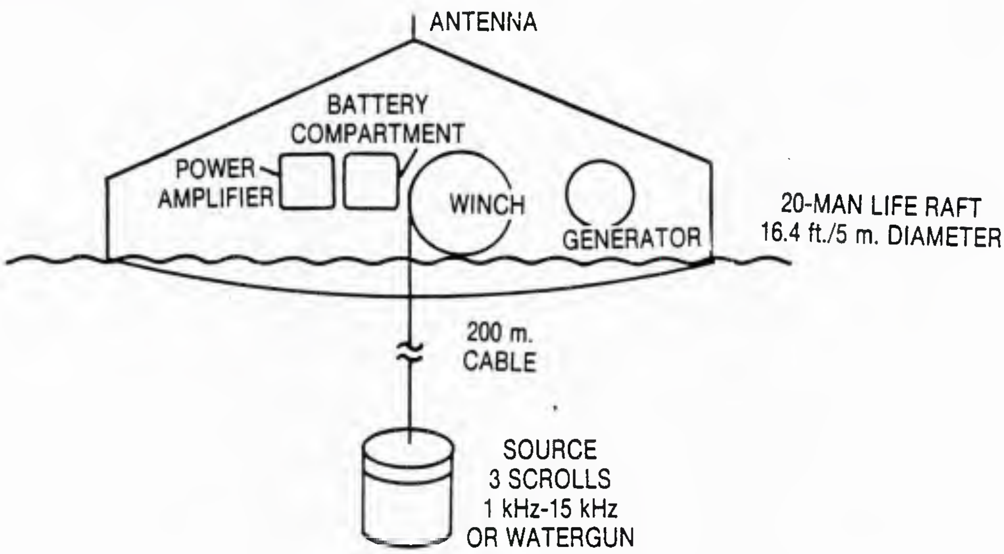
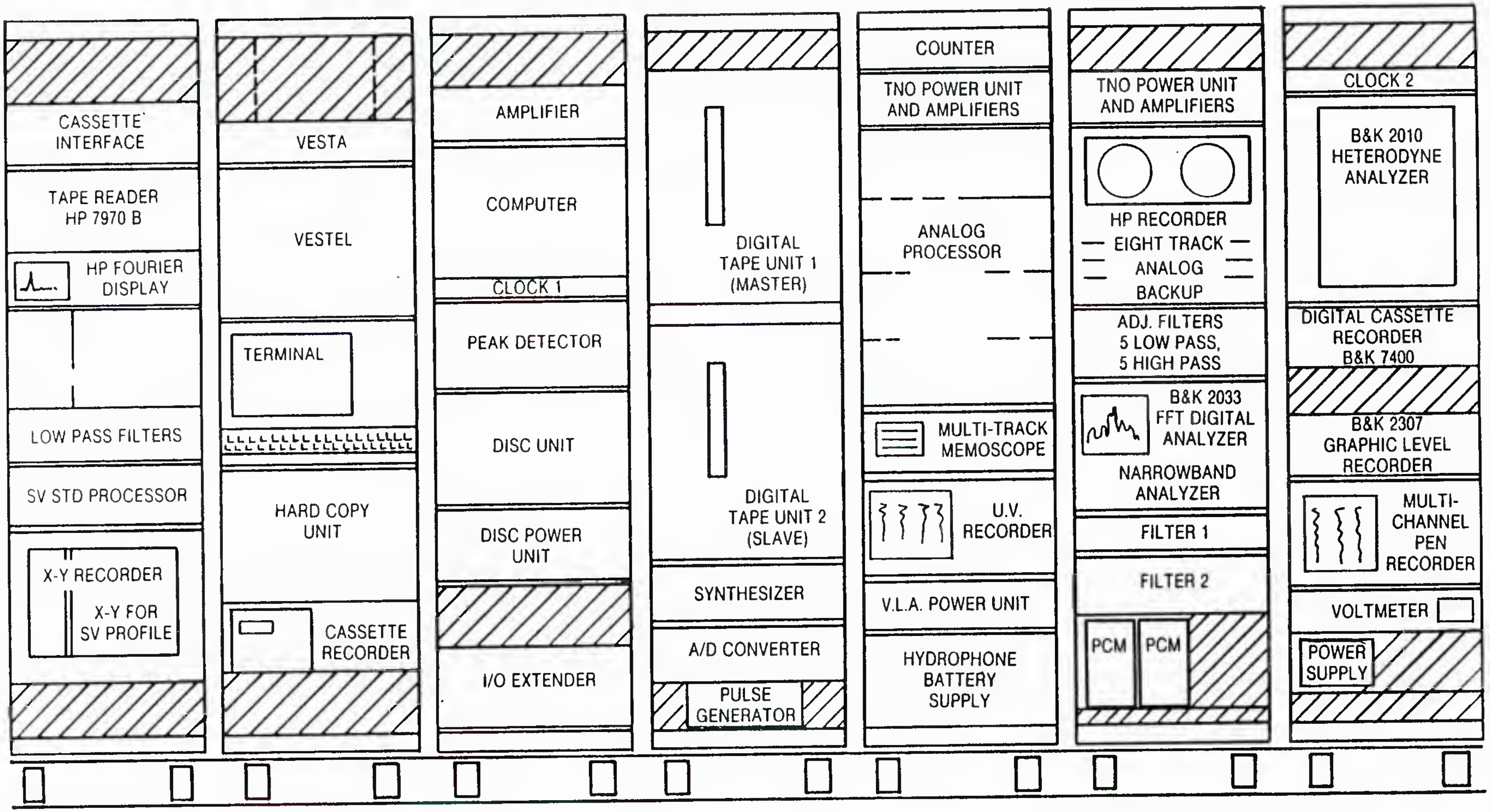


Figure 4-5. NEREUS



(INSTRUMENTATION SUBJECT TO FREQUENT CHANGE)

Figure 4-6. Container Instrumentation for Towed Array

Date of this Summary
31 May 1985

Facility Name: Measuring Station Nootdorp

Location: On a quiet lake at Nootdorp south of Leidschendam approximately 7.5 mi./12 km. east of FEL-TNO Laboratory in Den Haag

Cognizant Organization: FEL-TNO, under the Defense Research Branch of TNO (Netherlands Organization for Applied Scientific Research)

Facility Functional Name: Nootdorp Lake Facility

Major User(s): FEL-TNO, Netherlands Navy, other TNO institutes, University labs, etc.

Technical Areas Supported: Hydrophone, transducer and array development and calibration

Unique Features: Concentric shaft; either inner or outer shaft can be rotated with the other at rest, or both can be rotated together.

Significant Equipment Available: In general, equipment for use on the Nootdorp Lake Facility Barge is brought from FEL Laboratory in Den Haag when required.

Local Environment: Quiet lake; depth sloping from 50 ft./15 m. under barge to a few meters at 260 ft./80 m. from the barge which is moored at 150 ft./45 m. from the shore. Soft bottom consisting of fine mud (flyash) over sand.

Future Plans for Facility: No changes contemplated.

Facility Mailing Address: Physics and Electronics Laboratory TNO (FEL-TNO)
Oude Waalsdorperweg 63
P.O. Box 96864
2509 JG The Hague
Netherlands

Local Contacts: Ir. H.A.J. Rijnja
Ir. J. Verbiest
At above address
Tel: Int. Oper. + 31 70 26 42 21 Ext. 332

Contact for Access/Scheduling: Ir. J.G. Schothorst, as above

Narrative Description: The Nootdorp Lake Facility was built in 1960. It is easily accessible by automobile (and/or truck) from Den Haag, about 7.5 mi./12 km. from FEL-TNO. It is possible to drive across a small bridge over a canal at the entrance to the Facility and to load materials directly onto a small rail truck. The rail truck, in turn, can be pushed the short distance to a turntable which allows a left turn onto the track which leads straight into the barge. (See Figure 4-7.)

Narrative Description (Cont'd):

The track runs directly under the lifting tower for the large concentric shaft so that heavy units can be attached directly to the shaft for lowering into the well. The two lifting towers, for both the large heavy-duty rotatable shaft and for the lighter fixed shaft, can be seen above the rest of the barge structure in Figure 4-8.

The large concentric shaft is fixed in X-Y position but both shafts are independently rotatable and motor-driven. It can support a total of 5.5 US tons/5000 kg. either with 5.5 US tons/5000 kg. on one shaft (either shaft) or by dividing the load so that there is 2.75 US tons/2500 kg. on each shaft.

The lighter shaft can support 330 lb./150 kg. and is both fixed in X-Y position and non-rotatable. It is free to be raised and lowered to a maximum depth of 21.3 ft./6.5 m. Note again that the water depth under the barge is 50 ft./15 m.

The well dimensions are 6.5 x 11.5 ft./2 x 3.5 m. and can be extended another 1.6 ft./0.5 m. if necessary.

The general arrangement of the barge is given in Figure 4-9.

When not in use for calibration or experiments, the barge is totally unmanned. There is no guard or watchman and no air conditioning, so very little instrumentation is left onboard between measurements. Instrumentation is brought to the barge for each measurement as necessary.

Equipment remaining on the barge more or less permanently includes, of course, the 3-phase voltage regulator, the rotator and associated rotator control panel.

The barge is supplied with shore power. Normally brought to the barge is 220/380 volts, 3 Ø, 50 Hz, 10 kW, and spare shore power is available if needed. Of the above, 5.5 kW, 3 Ø is required onboard for the hoist.

400 Hz for the rotator is obtained from a converter onboard.

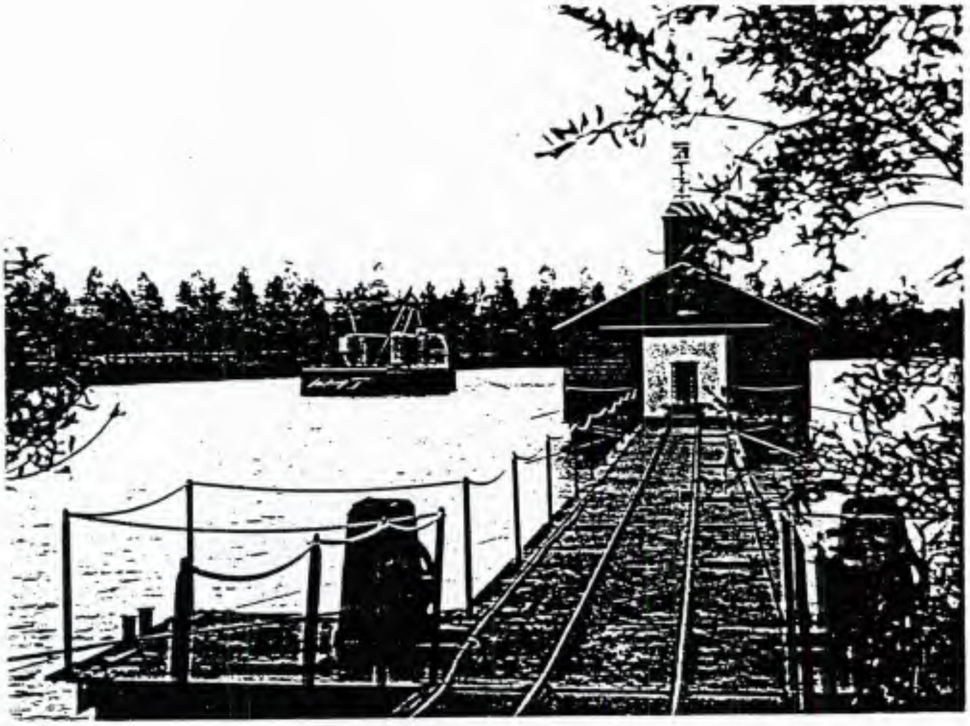


Figure 4-7. Showing Access and Tracks to Nootdorp Lake Facility Barge

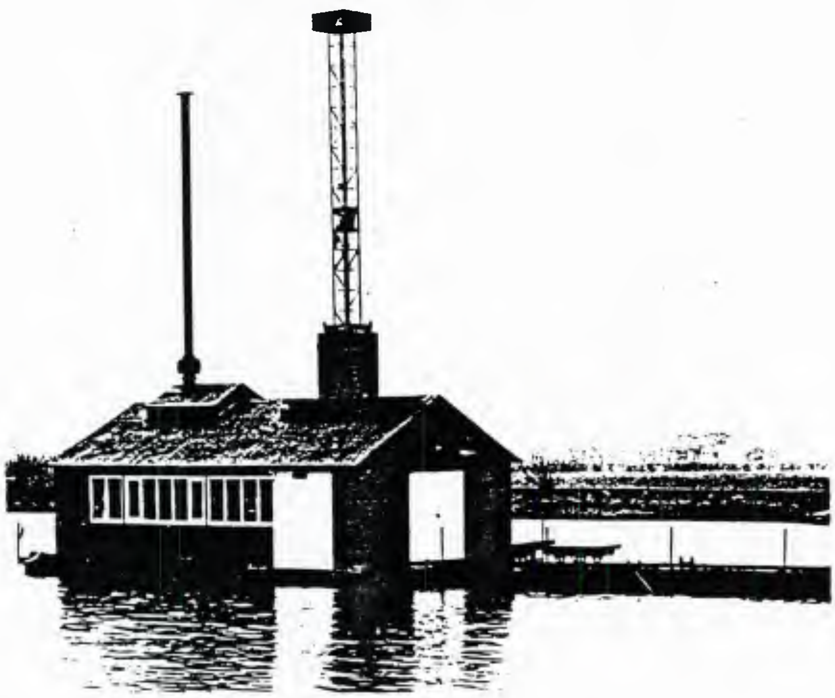


Figure 4-8. FEL-TNO Nootdorp Lake Facility Barge

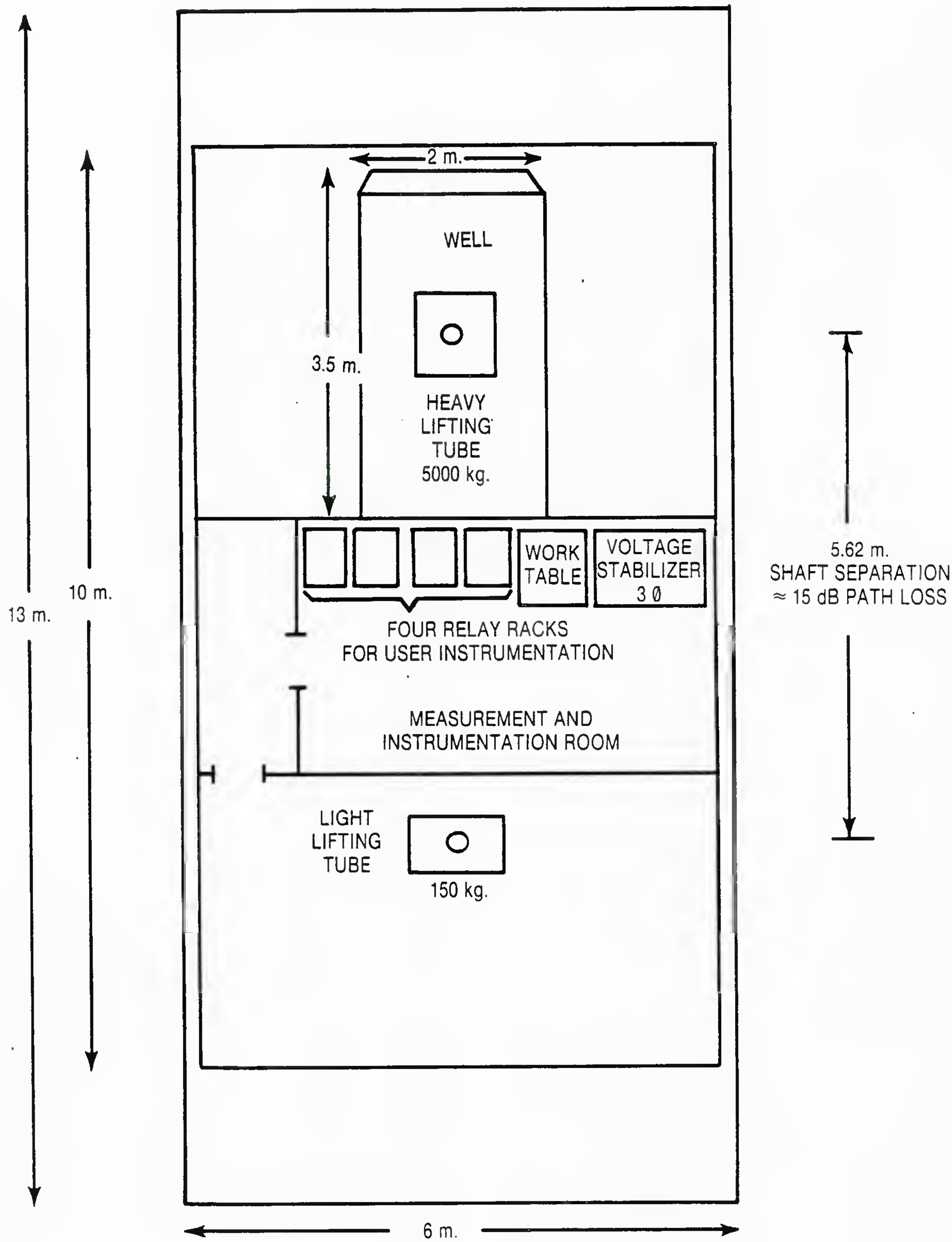


Figure 4-9. FEL-TNO Nootdorp Lake Facility Barge Arrangement

Date of this Summary
3 June 1985

Facility Name: TNO Institute of Applied Physics (in Dutch: Technisch Physische Dienst TNO-TH, abbreviated as TPD)

Location: On the grounds of the Delft Technological University (TU Delft) in buildings leased from the University, Delft, Netherlands

Cognizant Organization: Netherlands Organization for Applied Scientific Research (TNO). The Institute of Applied Physics is a member institute of TNO, but it retains a large degree of independence. Approximately 90% of its activity resulted from contract research, with the remainder derived from subsidization. Contract research is carried out for various governmental and commercial activities, national and international.

Facility Functional Name: Applied Physics Laboratory -- Acoustics Department

Major User(s): Shipowners, shipbuilding companies, Netherlands Navy, and foreign Navies

Technical Areas Supported: Noise control and acoustic signal processing

Unique Features: Reverberant water tank; permits a wide range of ship/hull/ noise studies on a realistic scale in the laboratory

Significant Equipment Available: Reverberant water tank; facilities for measurement of sound transfer through resilient materials under static load; large underwater ultrasonic scanner, as well as several in-air acoustic test facilities: large directional microphone array; anechoic rooms; reverberant room; room complex for architectural noise isolation studies; test facilities for air moving devices; and scale model facility for vehicular traffic/buildings noise studies. Extensive software package (TAS, Timeseries Analysis System) for signal analysis and image processing.

Local Environment: Laboratory is on the grounds of a city university. Acoustically quiet area, and key facilities are well isolated.

Future Plans for Facility: Continued routine operation of the Laboratory, with general development and improvement of instrumentation. Additional scale model tests of the effects on propeller noise of hullcoatings will be carried out. Facilities for investigation of transmission of machinery noise to the hull will be continued.

Facility Mailing Address: Acoustics Department
TNO Institute of Applied Physics
P.O. Box 155
2600 AD Delft
Netherlands

Visitors Address: Stieltjesweg 1
2628 CK Delft

Local Contacts: Head, Ship Acoustics Department (H.F. Steenhoek)
At above address
Tel: Int. Oper. + 31 (0)15 78 72 89/
Institute 31 (0)15 78 80 20

Contact for Access/Scheduling: H.F. Steenhoek

Narrative Description: The Institute of Applied Physics (TNO-TH) of Delft employs approximately 270 people and is composed of four major departments as shown in Figure 4-10 and has a yearly turnover of dfl. 42,000,000.00 (1986).

The Acoustics Department has approximately 70 members, including about six graduate students.

Most of the effort of the Acoustics Department goes into either consulting or research. The areas in which the department generally works are: Ship Acoustics; Mechanical Noise; Propeller Noise; Design/Prediction; Flow and Flow-Induced Noise; Industrial Noise; Architectural/Room Acoustics; and Traffic (Vehicular) Noise.

Facilities:

Reverberant Water Tank--The facility of major interest under the cognizance of the Ship Acoustics Department in terms of underwater acoustics is the large reverberant tank shown in Figure 4-11. The tank is housed in a building designed for that purpose and is isolated from the building and from the earth by resilient rubber mountings. Ambient noise is very low above seismic frequencies and the tank resonance is approximately 10 Hz.

The tank is essentially a section of a generic ship hull built inside out, with the water on the inside and the ribs and stiffeners on the outside.

The "hull" plating measures .28 to .35 in./7 to 9 mm. in thickness. The dimensions of the tank are 39.4 x 19.7 x 16.4 ft. deep/12 x 6 x 5 m. deep and the total volume is 12,729 $ft.^3$/360 m^3.

The tank is provided with four 550 lb./250 kg. davits, one 2.2-US ton/2000-kg. hoist and two movable foot bridges which can be seen in Figure 4-11.

There are three observation windows in the walls of the tank.

A variety of underwater sound sources (e.g., Dyna Empire J-9, J-11, J-13) and hydrophones is available.

Similarly, a wide variety of vibrators (or shakers) is available for use on the exterior of the structure with a selection of accelerometers. (The Derritron shakers and the B&K accelerometers and hydrophones appear to be favored.)

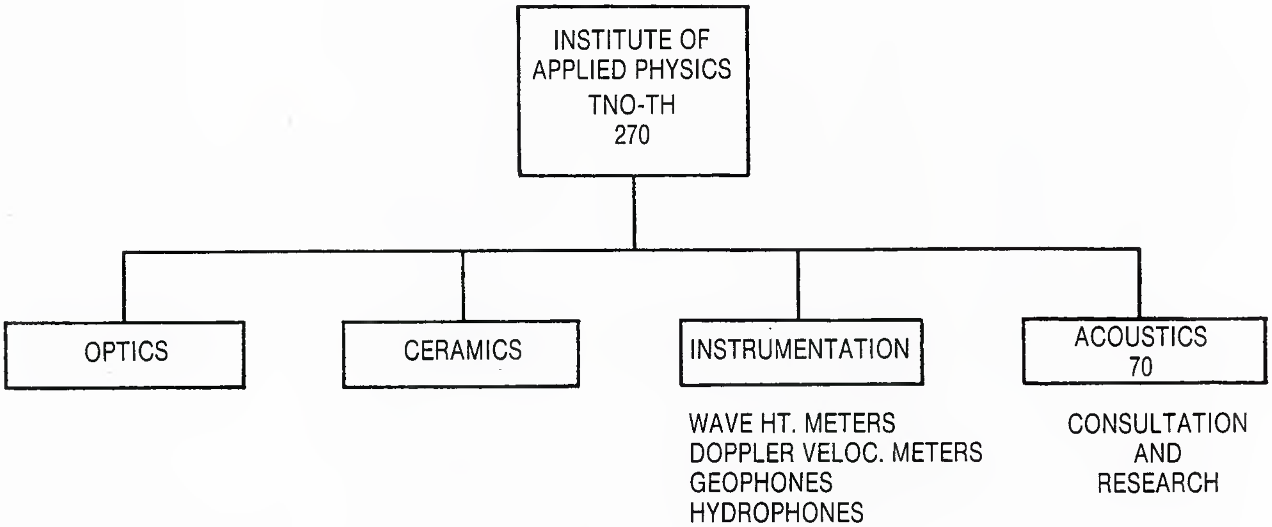


Figure 4-10. Organization of TNO-TH

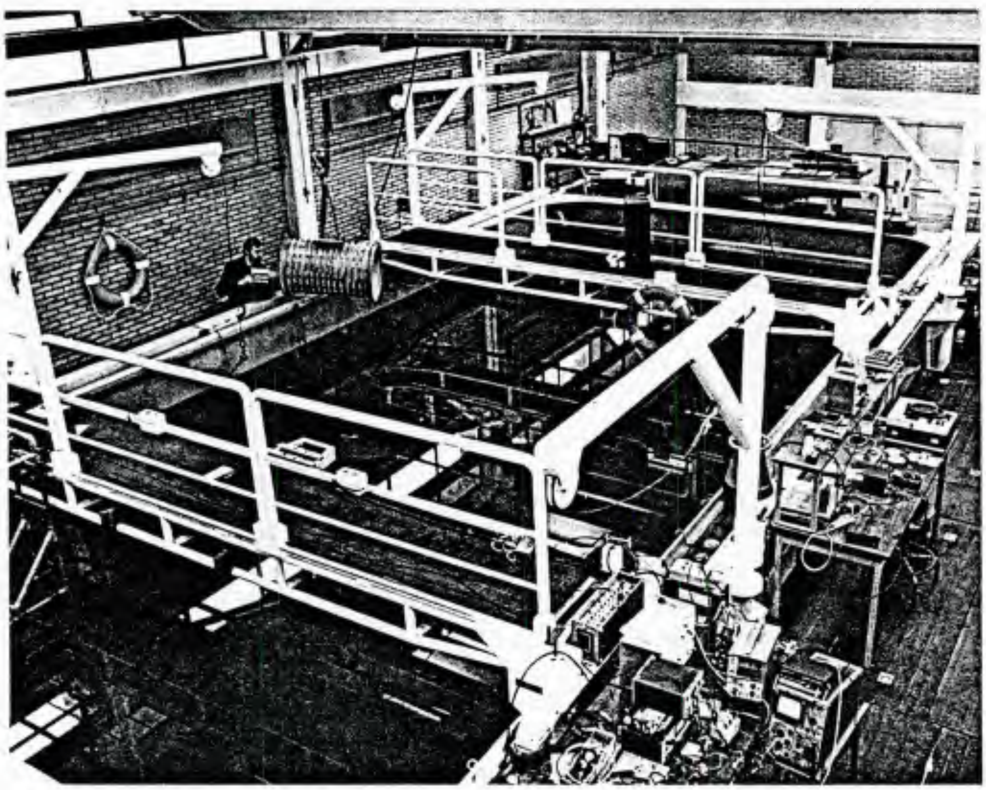


Figure 4-11. Large Reverberant Tank

Facilities (Cont'd):

Figure 4-12 shows some of the uses to which the tank is put:

No. 1 is a scale model of a section of a ship, partially coated, to study the transmission of propeller noise through the coating into the interior of the vessel. In a similar way scale models can be used to study the radiated underwater sound of ship machinery.

No. 2 is a cabin, installed as along the outer hull of a vessel, and is used to measure the noise radiated by cabin boundaries from transmitted machinery and propeller structureborne sound. The cabin is constructed, again by shipbuilders, of the materials normally used for this purpose and can be easily exchanged with other structures.

No. 3 represents the installation of a piece of machinery on a foundation rigidly coupled to the hull. The transmission of sound from the machine via the hull into the water is measured here, and the types of isolation mounts and/or foundations used can be varied. The effects of mounting locations with respect to ribs and stiffeners can be examined and the design of foundations in terms of weight and mechanical impedance can be optimized.

This is a very busy facility in demand by both civilian and military ship interests.

Test Facilities for Measurement of Sound Transfer through Resilient Mountings--Figure 4-13 is a diagram of the test arrangement used for measuring the isolation properties of resilient mountings of various simple or complex shapes. The test rig has been constructed so that translational and rotational vibrations can be applied along the X, Y, and Z axes. The upper block is excited in the required direction by means of electrodynamical shakers. The lower block is a blocking mass; and here the forces and torques exerted by the mounts under investigation are determined (Newton's Second Law). Generally, the mountings must be statically pre-stressed; compressional, shear and/or torsional. Special instrumentation is available for separate and accurate measurement of the translational and rotational vibration components.

The sound transfer properties along X, Y, and Z axes are of particular importance when installing noise sources on ships or other relatively lightweight structures.

The actual test experiment, including two Derritron shakers, can be seen in Figure 4-14.

Ultrasonics/Echo Acoustics--There is an active ultrasonics program at TU Delft which includes tanks and associated equipment in the laboratory used in a limited way for cleaning but principally for non-destructive testing.

A device in the laboratory has been constructed for the purpose of underwater ultrasonic scanning. The application is the examination of steel-reinforced concrete structures, primarily in connection with North Sea Oil construction. The scanner can detect surface cracks and can look up to 1.6 ft./0.5 m. in depth into the concrete. (Scattering becomes the limiting factor, however, and

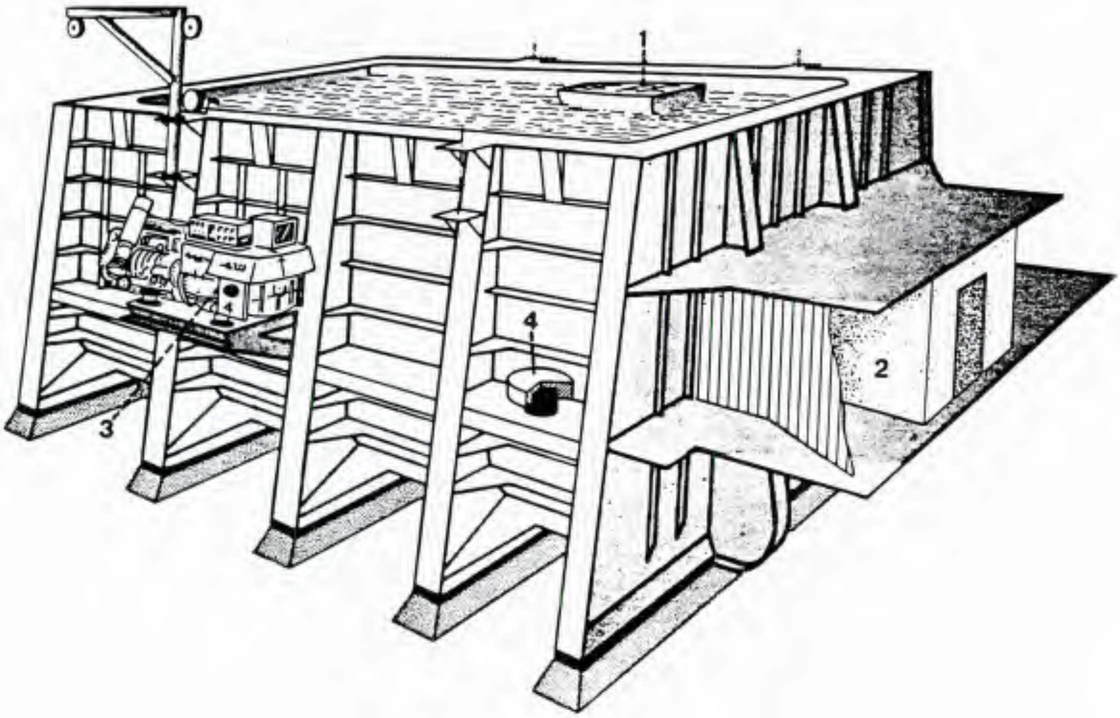


Figure 4-12. Some of the Uses for the Large Reverberant Tank

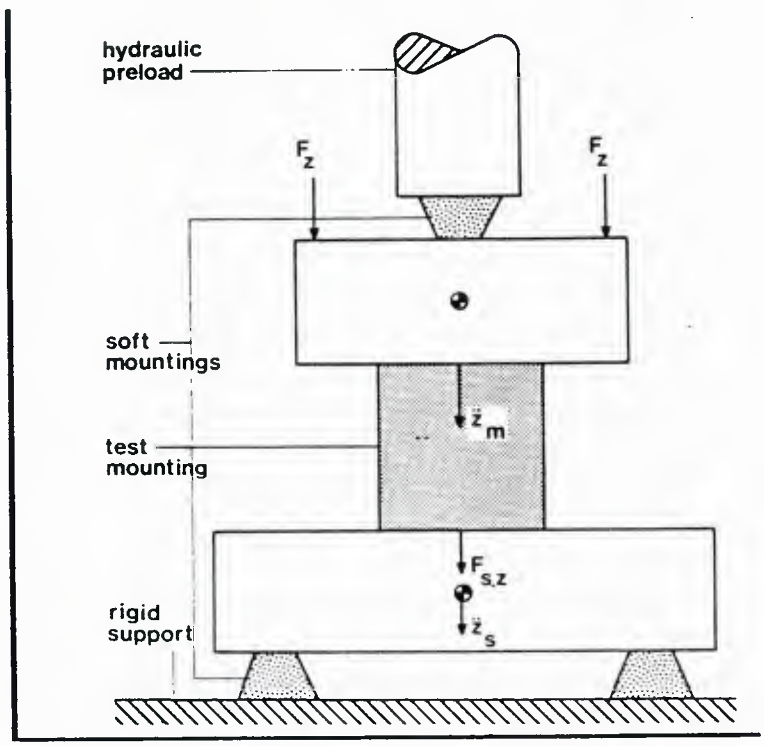


Figure 4-13. Diagram of Resilient Mounting Test Arrangement

Facilities (Cont'd):

precludes obtaining much useful information from deep examinations.) Crack depths can be determined and, more importantly, a determination can be made of locations where a crack has exposed the internal reinforcing steel to corrosion.

Another underwater ultrasonics device was designed to detect the presence and extent of sand deposition on large flat surfaces laid on the bottom. The specific application was in connection with the construction of a 5.6-mi./9-km. long storm surge barrier at the entrance of the Eastern Scheldt Estuary. As part of the construction, a number of "mattresses" made of gravel and concrete blocks are laid on the bottom at critical points. On top of each of these 66 "mattresses" will be placed the base plate of one of the large piers. The base plate is a concrete slab 82 x 164 ft./25 x 50 m. and the concrete block surface of the "mattress" must be free of sand before the plate is laid on it. TU Delft constructed a prototype sedimentation measurement system (retained in-house) and then produced four multi-channel systems for the Netherlands Ministry of Transport and Public Works for installation on existing bottom crawlers. The final system operates at either 0.5 or 1.0 MHz (selectable) and is capable of measuring the thickness of a sand layer up to 5.9 in./15 cm. with 0.04 in./ 1 mm. accuracy.

In-air acoustics has been a large part of the TPD program since its founding in 1941. Although not of immediate concern to this survey, some of the air acoustics work is potentially of interest to ships and submarines.

One significant in-air acoustic facility is called SYNTACAN for Synthetic Acoustic Antenna. SYNTACAN is essentially a mobile directional sound measurement system (see Figure 4-15). It uses an array of up to 32 microphones on a 250-ft./76-m. long baseline with a resolution of 1.5°. SYNTACAN is used generally in connection with industrial noise problems at frequencies between 90 and 1400 Hz.

The facilities for architectural and room acoustics are extensive. Figure 4-16 gives a plan view of some of these facilities.

The Reverberant Room in Figure 4-16 has a volume of 7060 ft^3./200 m^3. and is an irregularly shaped concrete structure mounted on resilient rubber isolating material. Diffuser panels are suspended above the floor to produce a diffuse acoustic field. The Room has reverberation times of 15, 8, and 3 seconds in the low, medium, and high frequency ranges respectively.

The function and description of the two anechoic rooms seen in Figure 4-17 are summarized below:

Function: Measurement of the sound power spectrum and directivity of sound sources, free-field calibration of microphones, measurements on loudspeakers, etc.

Description: Cube shaped concrete rooms, resiliently mounted on rubber (large room) or adjustable air springs (small room).

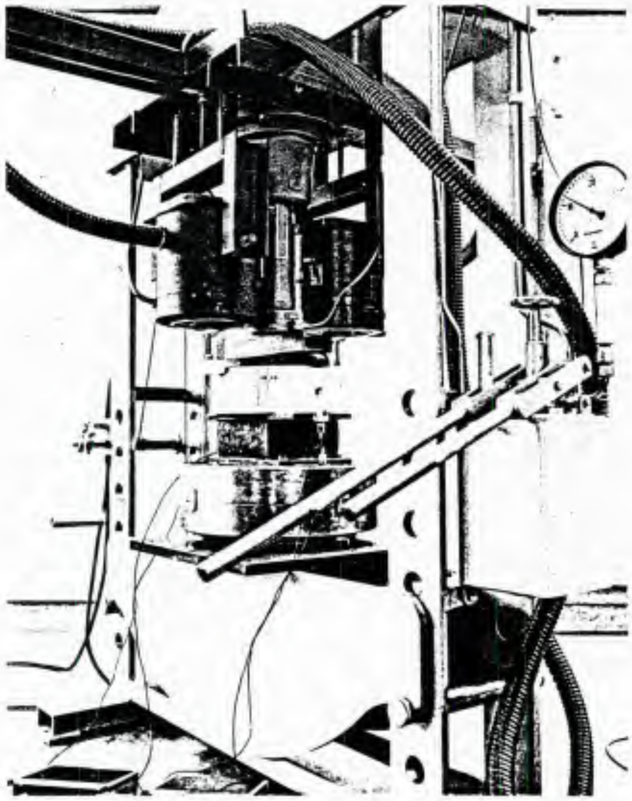


Figure 4-14. Resilient Mounting Test Equipment

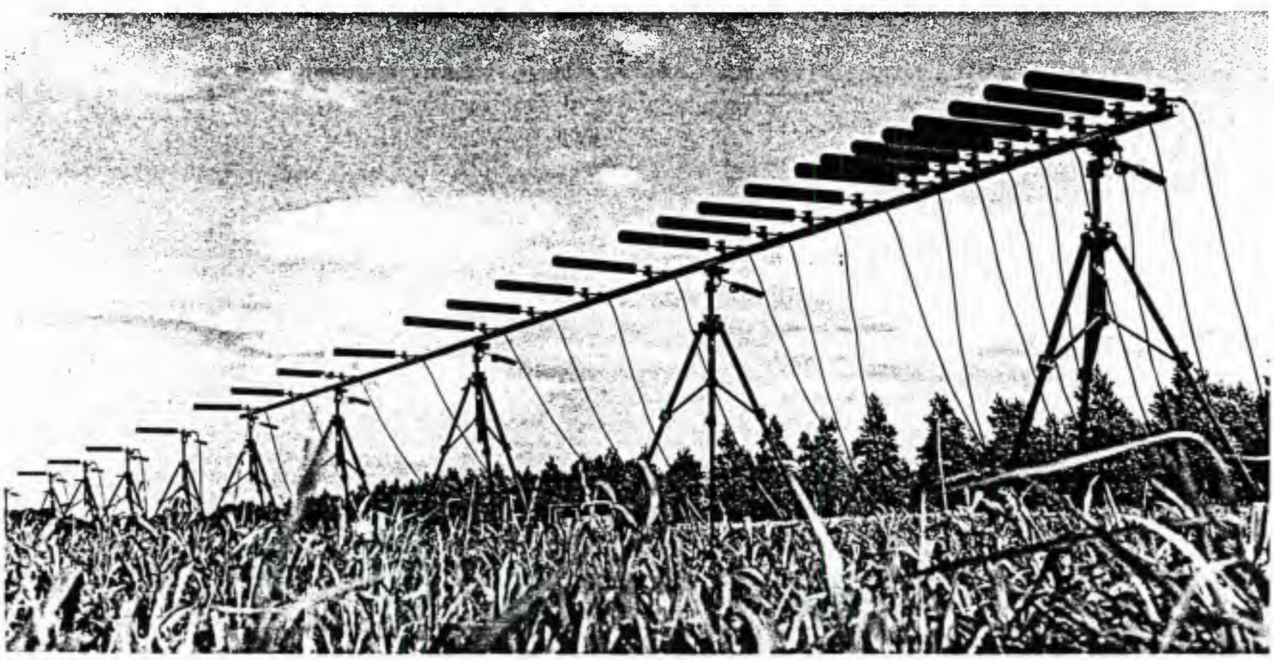


Figure 4-15. SYNTACAN

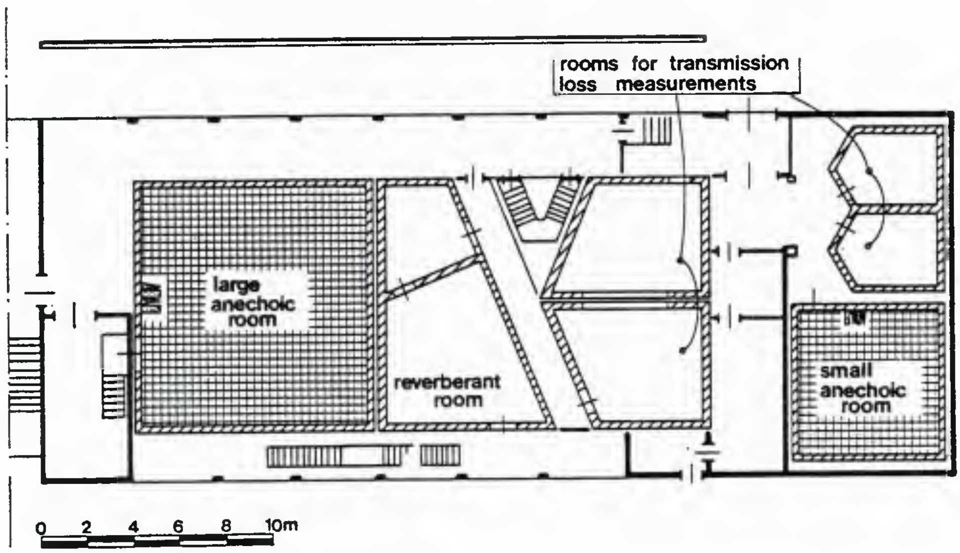


Figure 4-16. TH Facilities for Room Acoustic Studies

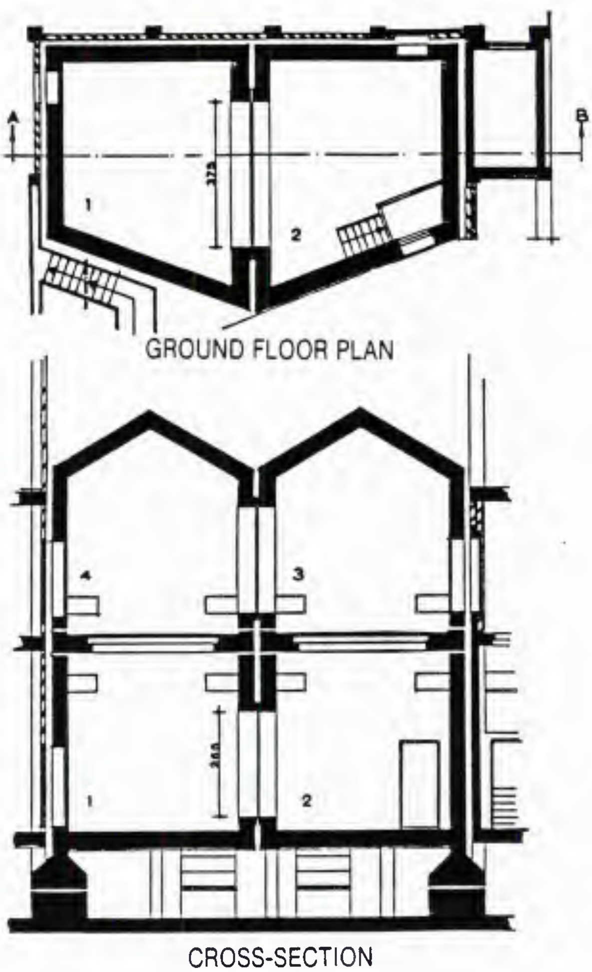


Figure 4-17. TH Acoustic Isolation Rooms

Facilities (Cont'd):

Inner dimensions:
large room: 33 x 33 x 33 $ft.^3$/10 x 10 x 10 $m.^3$
free volume: 18,080 $ft.^3$/512 $m.^3$
small room: 14.8 x 14.8 x 14.8 $ft.^3$/4.5 x 4.5 x 4.5 $m.^3$
free volume: 2,259 $ft.^3$/64 $m.^3$
The sound-absorbing material on the walls consists of wedges made from special polyurethane foam.
Length of wedges: large room: 3.28 ft./1 m.;
small room: 1.6 ft./0.5 m.
Floor: open network of steel wires
Cut-off frequency: large room: 85 Hz
small room: 250 Hz

The anechoic rooms are very intensively used. In-air submarine target studies have been done and there are also plans for a repeat with more advanced instrumentation before doing near-field in-water measurements.

The rooms identified as intended for transmission loss measurements are shown in more detail in Figure 4-17.

The function and description of these isolation rooms are summarized below:

Function: Measurements of airborne and impact sound insulation of walls, facades, and ceilings in accordance with International Standard ISO 140.

Description: Four measuring rooms of 3530 $ft.^3$/100 $m.^3$ each. The rooms are situated in such a way that two openings are available for the investigation of wall structures and two other openings for the investigation of floors and ceilings.
Two smaller rooms of 1765 $ft.^3$/50 $m.^3$ each. These rooms are suitable for measurements on light partitions and on suspended ceilings with a plenum above.
All rooms are resiliently mounted, the four large ones on rubber and the two small ones on adjustable air springs.
Dimensions of the measuring openings: 107 $ft.^2$/10 $m.^2$
To reduce flanking transmission, the large rooms are mutually isolated, both vertically and horizontally.
The concrete walls of the large rooms are 1.3 ft./0.4 m. thick.
One of the floor openings in each of the large rooms can be used for sound insulation measurements on arbitrary structures; the other one is permanently closed by a floor of 3.94 in./10 cm. thickness and is used for the determination of impact sound insulation of floor coverings.
The facilities are also applicable for investigation of shipboard wall and deck structures.

In the general area of architectural acoustics and noise control are noise problems arising from the use of air conditioners, ventilators, and other air moving devices. Since TPD bears responsibility in this area and is frequently consulted in connection with such problems, the necessary facilities for making

Facilities (Cont'd):

appropriate measurements are maintained. The general plan for the spaces devoted to this subject is given in Figure 4-18.

The function and description of the above facilities are summarized below:

Function: Measurement of noise produced by ventilators and other air moving devices.
Measurement of noise produced by air movement through ducts, control valves, anemostates, induction units and silencers.
Measurement of the transmission loss and the insertion loss of silencers.

Description: The test facility has three rooms: a fan room, an instrument room, and a measuring room.
Fan room and measuring room are connected by an air duct. A silencer has been installed immediately behind the fan.
Silencers under test are installed in the part of the air duct that crosses the instrument room.
The desired air velocity in the duct is obtained by varying the speed of the fan.

One special facility at TPD concerns ground vehicular traffic noise. Here, microphones are located in model buildings next to modelled streets and highways. Vehicular traffic noise is simulated with a compressed air noise source which produces a broad band hiss. The source is pulled back and forth past a model building which is supplied with trees, shrubs, lawns, and other baffling and/or sound-absorbing materials. These model simulations are located in a semi-reverberant room at TH shown in Figure 4-19.

Signal acquisition and processing facilities

Timeseries analyzing package (= TAS package)--TPD is developing a new and versatile timeseries analyzing software package, meant to offer improved signal processing facilities. The package will be available at the beginning of 1987 on a micro VAX GPX system.

Features:
- Hardware independent, software transportable to other systems
- Open ended structure
- Interactive programming facilities
- Large background memory

Acoustic workstation--At the end of 1987 a transportable acoustic workstation is to be developed. The acoustic workstation will incorporate the TAS signal processing package, next to data acquisition and preprocessing facilities.

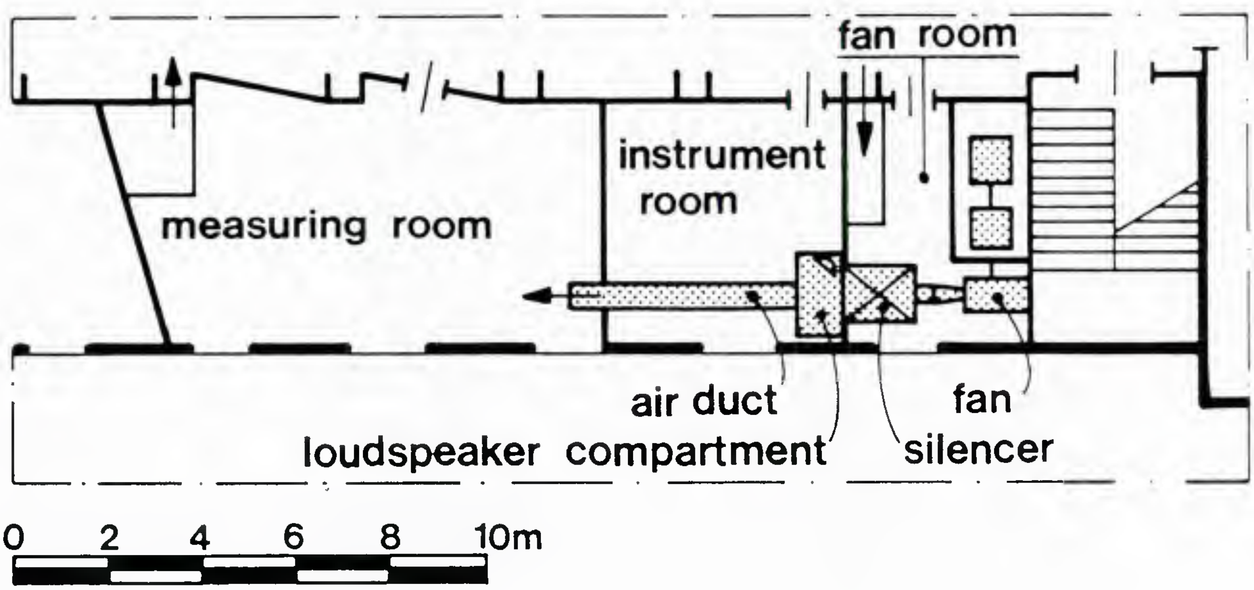


Figure 4-18. TH Facilities for Noise Measurements of Air Moving Devices

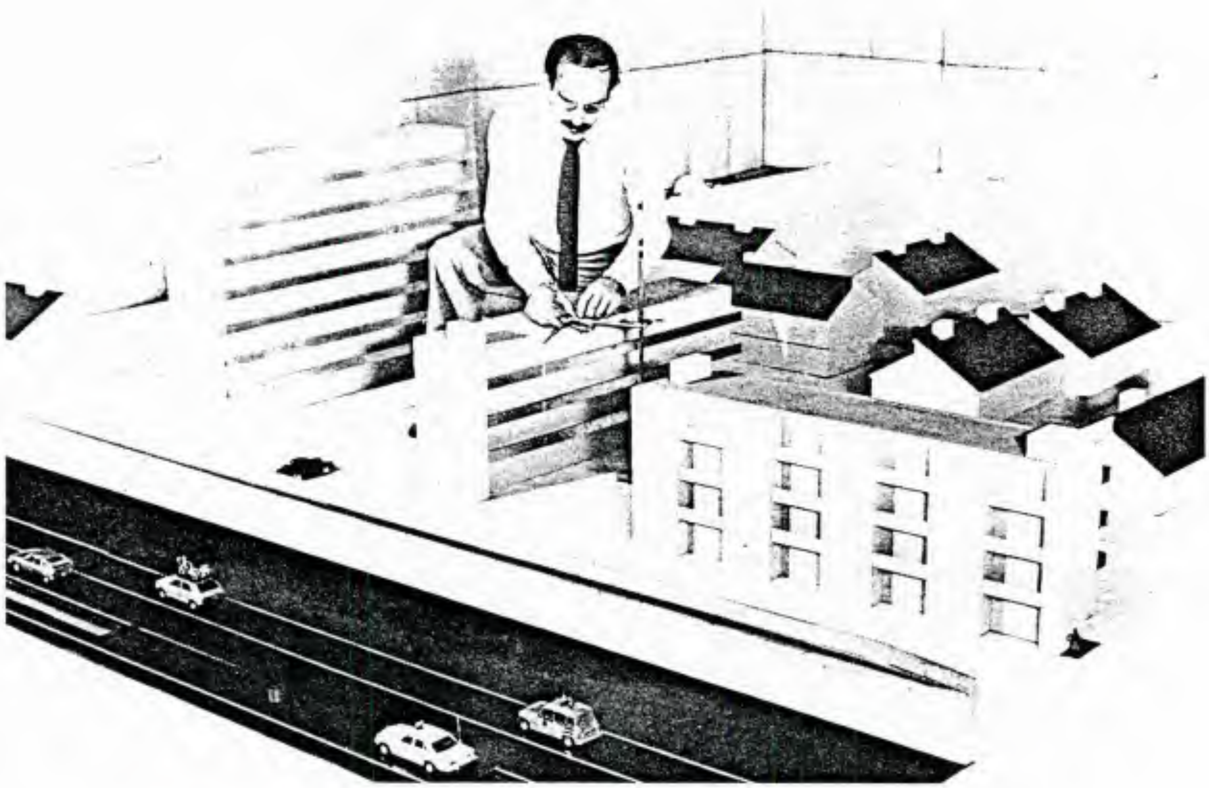


Figure 4-19. TH Facilities for Vehicular Traffic Noise Studies

Date of this Summary
6 June 1985

Facility Name: Maritime Research Institute Netherlands (MARIN)

Location: MARIN (Ede) is located in Ede, a small city in the central Netherlands, midway between Utrecht and Arnhem. The building is on Niels Bohrstraat in the industrial sector of the city.

Cognizant Organization: MARIN Headquarters is in Wageningen, Netherlands.

Facility Functional Name: Depressurized Towing Tank and Model Shop

Major User(s): 80% commercial contracts (shipbuilders, shipping companies); 20% Netherlands government (Navy, Ministry of Transport and Waterways, basic research)

Technical Areas Supported: Propeller design, cavitation studies, hull design

Unique Features: Large towing tank which can be depressurized for cavitation and noise studies as part of the model scaling

Significant Equipment Available: The large depressurized towing tank which can accept 30:1 scale models of large ships; instrumentation in the towing tank includes dynamometers, strain gauges, laser Doppler velocimeter scanner, strobe lighting, underwater photographic and videotape systems, pressure transducers, and hydrophones

Local Environment: MARIN (Ede) is in an isolated building on a quiet street in the industrial zone of a small city.

Future Plans for Facility: There are plans to improve the towing tank facility over the period 1986-1988 if feasible. Carriage speed is to be increased and tank noise/carriage noise is to be reduced.

Facility Mailing Address: Maritime Research Institute Netherlands
Niels Bohrstraat 10
6716 AM Ede
Netherlands

Local Contacts: Ir. J. Th. Ligtelijn
Ir. J. van der Kooij
At above address
Tel: Int. Oper. + 31 8380 78111

Contact for Access/Scheduling:
Head, Ship Powering Department
Industrial Projects Division
Maritime Research Institute Netherlands
2 Haagsteeg; P.O. Box 28
6700 AA Wageningen
The Netherlands
Tel: Int. Oper. + 31 8370 93911

Additional Information: "Cavitation Testing of Marine Propellers in the NSMB Depressurized Towing Tank," Conference on Cavitation, Edinburgh, Sept. 1974, by G. Kuiper.

"Acoustic Measurements in the NSMB Depressurized Towing Tank," by J. van der Kooij and A. de Bruijn; paper presented at a NATO/DRG Seminar on Advanced Hydrodynamic Testing Facilities, 26-28 April 1982, The Hague. (Also published in International Shipbuilding Progress, Vol. 31, No. 353, January 1984.)

Narrative Description: The Maritime Research Institute Netherlands (MARIN) was founded in 1981 by the merger of two earlier organizations: the Netherlands Ship Model Basin (NSMB) in Wageningen and Ede and the Netherlands Maritime Institute (NMI) in Rotterdam. The intent of this merger was to "establish a single maritime research establishment embracing all scientific disciplines needed to meet the demands of the shipping and shipbuilding industries." MARIN operates as an independent non-profit institute with Dr. M.W.C. Oosterveld as Managing Director.

MARIN currently employs approximately 350 people, distributed as indicated in Figure 4-20.

In Ede, the staff of 70 includes 35 persons in the Model Shop and 35 devoted to R&D tasks and to the operation and maintenance of the Towing Tank.

Twenty percent of the work at MARIN comes from the Netherlands government and 80% is derived from commercial/industrial sources.

MARIN Work Distribution

20% Government Work			80% Commercial/Industrial Work	
Navy Contracts	Basic Research	Ministry of Transport & Waterways	70% Contracts (Mainly with Shipyards)	10% Sponsored Research
5%	10%	5% Ocean Engineering Shallow Water Basin Ship Powering	20% Netherlands 50% Foreign	Encompasses the contract for CRS (Cooperative Research on Ships) which includes USN since 1980

Figure 4-20. Two Locations of MARIN

Narrative Description (Cont'd):

With the advent of larger oceangoing vessels (supertankers, etc.) and the need to maintain ship model scales no greater than 30:1, it became necessary to build wider and deeper towing tanks. The previously built towing tank (in Wageningen) constructed in 1932 (modified in 1951) measured 820 x 34.4 x 18 ft. deep/250 x 10.5 x 5.5 m. deep. The new towing tank, in Ede, was built in 1972 to meet those needs for larger models and measures 787 x 59 x 26.2 ft. deep/240 x 18 x 8 m. deep.

In addition to the increase in depth and width, the new towing tank is airtight and capable of being depressurized with 7 large vacuum pumps. This permits the air pressure in the 1,059,440 ft.^{3}/30,000 m.^{3} space above the water to be adjusted (to the scale of the model under test) for cavitation testing.

The carriage, which can be seen bridging the tank in Figure 4-21, is constructed of cylindrical steel tubes 8.2 ft./2.5 m. in diameter. The carriage rides on 32 wheels and is pulled by steel cables, in turn driven by an electric motor. The air within the carriage tubes is maintained at atmospheric pressure so that it could, if necessary, be manned during test operations. In fact that is rarely required since most operations are remotely controlled.

An air lock is provided for bringing models into and/or out of the towing tank while it is depressurized, and a separate personnel air lock is also provided.

A cutaway view of the DTT is given in Figure 4-22. Here the locks can be seen, as well as a ship model positioned below the carriage.

The power for the Tank, including the drive system, is derived from a 410 kW thyristor controlled power supply.

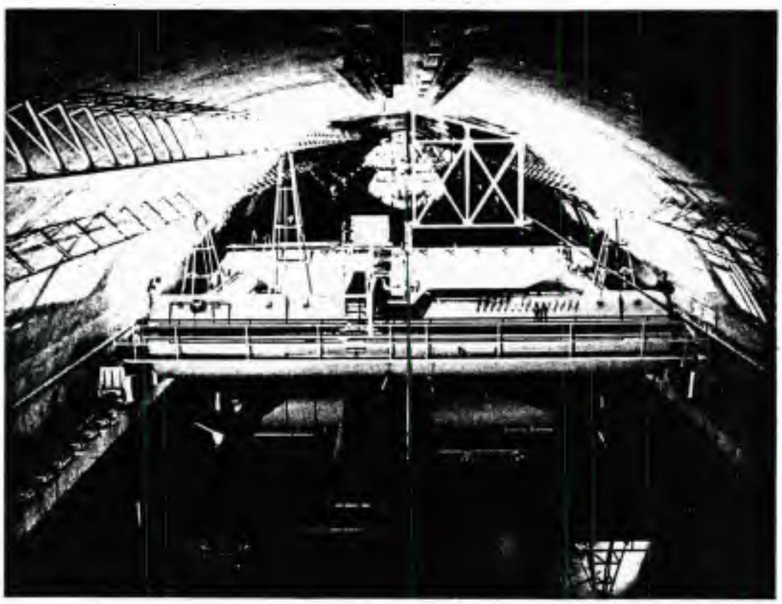


Figure 4-21. MARIN (Ede) Depressurized Towing Tank

Narrative Description (Cont'd):

The maximum carriage speed is 8.23 kt./4.25 m/s. and the carriage speed is remotely controlled by a DEC 11/44 computer.

The minimum air pressure which can be maintained is about 4% of normal atmospheric pressure, about 0.6 psi/0.04 bars. All pressures between this value and normal atmospheric pressure are used.

In addition to the normal model tests, such as resistance measurements, propulsion tests, and wake measurements, the depressurizing capability broadens the possible scope of cavitation testing and the testing of associated phenomena, including propeller-induced pressure fluctuations and cavitation noise.

The most often used model scales range from 5 to 30. The resulting model lengths then range from 18-42 ft./5.5-13 m. Scaled propellers used on the models vary in diameter from 7.9 in./0.2 m. to 15.7 in./0.4 m.

Due to the fact that the water in the tank is stagnant, the nuclei density is extremely low and it is necessary to generate nuclei artificially when performing cavitation tests. It is customary to provide the nuclei by means of electrolysis ahead of the propeller. The strength of the electrolysis current varies with the tank pressure and model speed, generally falling between 0.2 and 1.0 Amperes.

Similarly, roughness in the form of carborundum grains (of diameter about 0.002 in./0.06 mm.) glued onto all leading edges is provided.

During cavitation measurements, the type of cavitation and the point of inception are determined and the source strength and the far-field sound-pressure levels are measured.

Radiated noise measurements are made using two TNO-built ZP-84 hydrophones fixed in position beneath the path of the model, about midway along the tank. (See Figure 4-23.) One hydrophone is located directly on the midline at a depth of 6.6 ft./2 m. and the other is located 7.3 ft./2.24 m. off the midline at a depth of 3.6 ft./1.1 m.

The frequency at the low frequency end of the spectrum is limited by the background level of the DTT to about 1 kHz and the upper frequency is limited by the instrumentation to about 80 kHz. The instrumentation/recording system used is shown in Figure 4-24.

A plot of the noise level in the Depressurized Towing Tank as measured by the hydrophone below the midline for a model passing at a speed of 3.9 kt./2 m/s. is given in Figure 4-25.

There are plans to increase the maximum carriage speed and at the same time to decrease the noise level due to the carriage motion itself (seen in Figure 4-25 as the peaking below 1 kHz) and due to the thyristor control peak in the 8-60 kHz region.

The Model Shop of MARIN (Ede) is an important adjunct to the Depressurized Towing Tank and a significant facility in its own right.

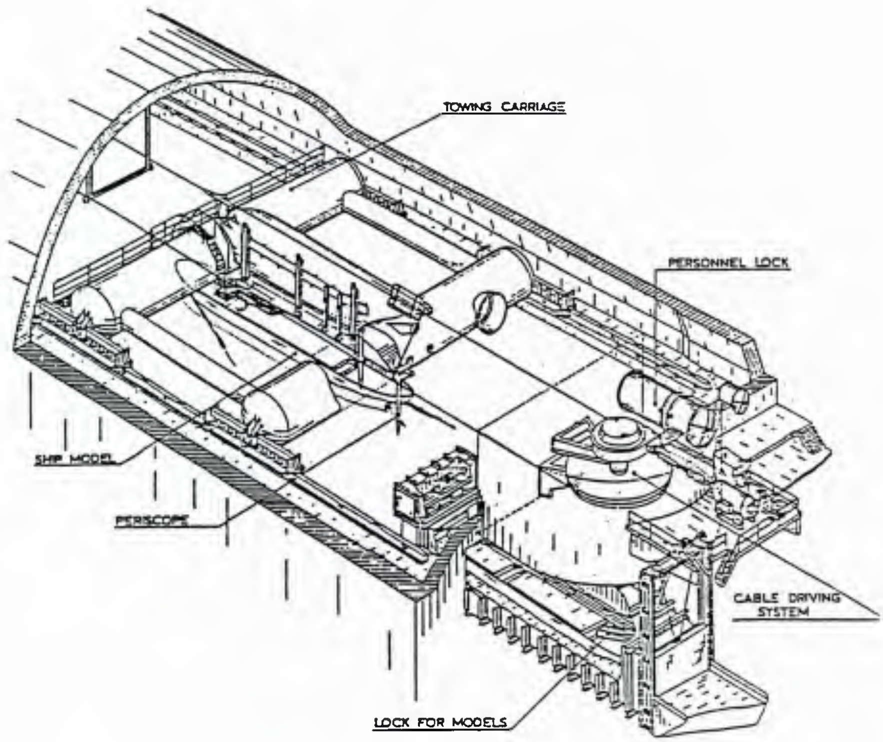


Figure 4-22. Cutaway View of MARIN (Ede) Depressurized Towing Tank

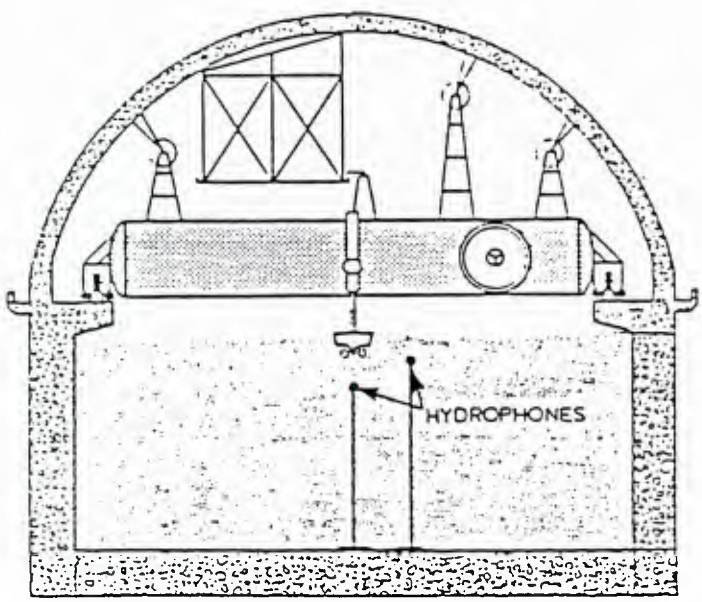


Figure 4-23. Receiving Hydrophone Positions in Relation to Model

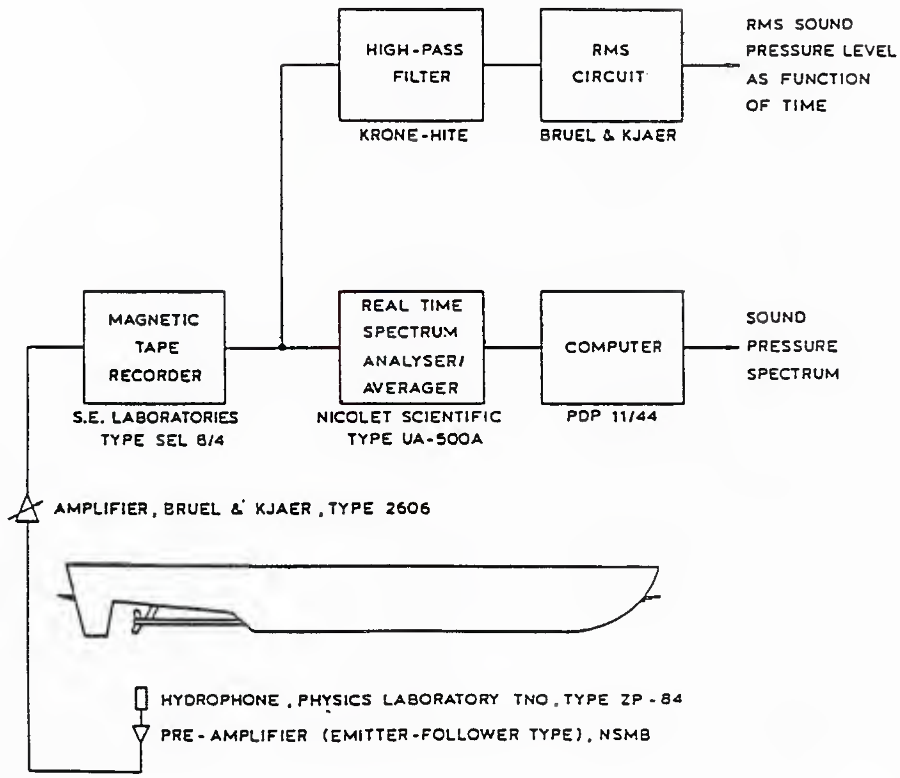


Figure 4-24. Block Diagram Acoustic Data Recording and Processing

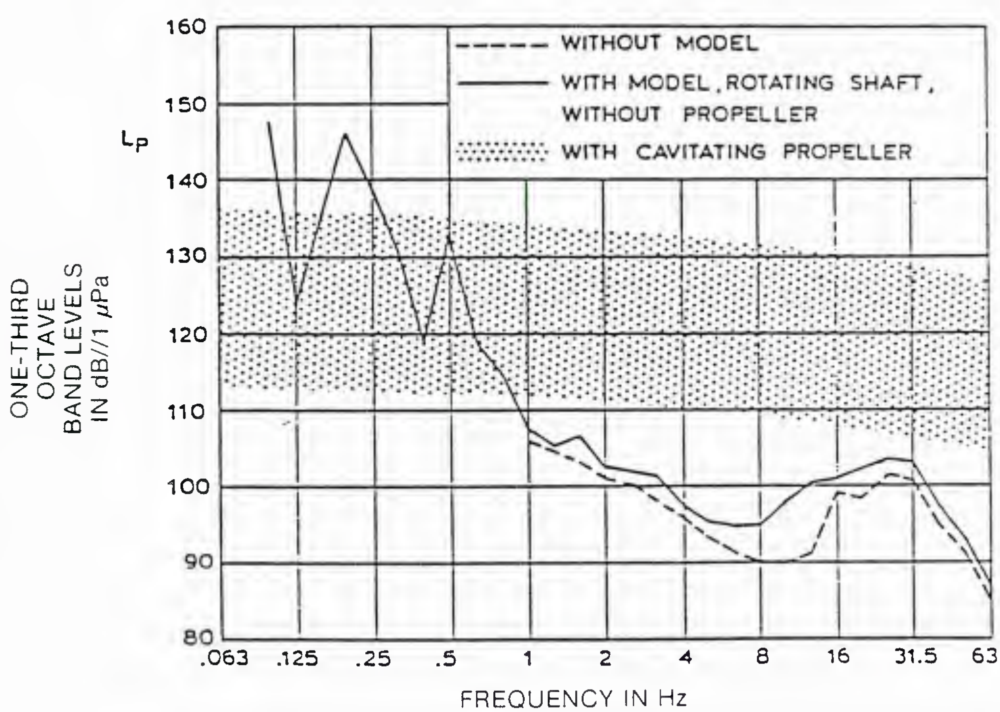


Figure 4-25. MARIN (Ede) Depressurized Towing Tank Noise Levels

Narrative Description (Cont'd):

The models are built to order, either from the customer's plans or from new plans proposed by MARIN. The models, after testing, are the property of the customer and may be sent to the customer or, in some cases, stored at MARIN in the event of future modifications desired or further tests.

A typical Frigate model, at a scale of 15:1, measures 26 to 29 ft./8 to 9 m. in length. Such a model, of the most durable construction, would cost (at an exchange rate of $1 = 2 fl) about 70,000 fl ($35,000), including all appendages except for propeller. A single propeller (typically 5-bladed, controllable pitch) would cost an additional 20,000 fl ($10,000) and a twin screw would cost 40,000 fl ($20,000). The costs for a large tanker model (length of 39 ft./12 m.) would be about the same.

Three different types of models are routinely made:

Economy model: Wax, with or without wooden reinforcement and a fiberglass matrix on the interior surface, including standard hull appendages (~30,000 fl)

Standard model: Wooden, optionally covered with thin fiberglass matrix and resin and painted, including standard hull appendages (~35,000 fl)

Longlife model: Wooden, covered with Araldit (plastic material) and painted, and with fiberglass matrix on the interior and exterior surfaces, including standard hull appendages (~70,000 fl)

Figure 4-26 shows "longlife" model of a VLCC under construction with a wooden core covered with Araldit.

"Economy" and "standard" models are used in relatively short test programs (up to about one year). "Longlife" models are used in test programs that continue over a number of years, usually for naval projects.

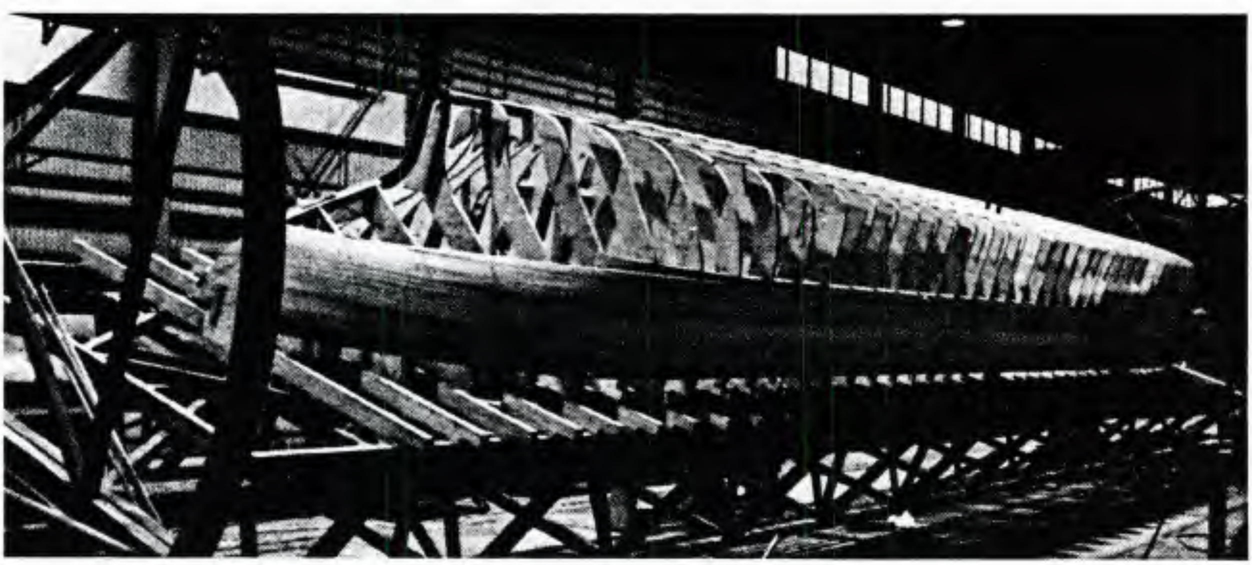


Figure 4-26. Wooden Core of Wood-Reinforced Araldit Model

Date of this Summary
1 July 1985

Facility Name: Erprobungstelle der Bundeswehr (Test Station for the Defense Department) with Aschau Messtelle (Aschau Ship Noise Range)

Location: In West Germany, in Eckernförde, on the coast at the western end of the Eckernförder Bucht (Bight, or Inlet), 18.5 mi./30 km. northwest of Kiel

Cognizant Organization: Bundeswehr (Ministry of Defense)

Facility Functional Name: E71 Erp. St. (Test Station) and Aschau Ship Noise Range

Major User(s): German Navy, Allied Navies, and German shipbuilders

Technical Areas Supported: Ship radiated noise, noise quieting

Unique Features: Aschau Range (Messtelle Aschau) track runs northeasterly over two hydrophone groups separated by about 0.8 mi./1300 m. The track runs normal to an extended array and crosses it at one end of the track. The long array extends 3280 ft./1000 m. off the track in a northwesterly direction, with hydrophones at 328 ft./100 m. intervals. Hydrophone doublets on the track are for source localization purposes.

Significant Equipment Available: "Messtelle Aschau," fully equipped ship noise measurement range on coast; mobile measurement system used on any platform, used for special tests not performed on the range (e.g., torpedo noise tests). (Plön Lake Calibration Facility to be described as a separate entry.)

Local Environment: Aschau Range hydrophones are in relatively shallow water, 65-85 ft./20-26 m. on a mud over sand bottom. Hydrophone array fouling problem is severe in this area. The Range is ice-covered from 1 January to 1 March during a severe winter. Baltic water salinity is 6 parts/million in the vicinity of Eckernforde.

Future Plans for Facility: A data cable is planned, which will run from the computer at Aschau to the computer in the Laboratory at Eckernförde. Array hydrophone spacing to be reduced and array to be shortened.

Facility Mailing Address: Direktor Erpst Borchardt
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Berlinerstrasse 71
D-2330 Eckernförde
Germany

Local Contacts: Direktor Borchardt at above address
Mr. Hans Arens (Aschau Range)
Tel: Int. Oper. + 49 43 51 40 41

Contact for Access/Scheduling: Direktor (Dr.) Borchardt, as above

Narrative Description: Erprobungstelle der Bundeswehr, also known as E71 and/or Erp. St. 71, as one of the Federal Armed Forces Test Centers, is part of the German Federal Ministry of Defense. The organization of the Ministry of Defense is given in Figure 5-1.

E71 is an organization of 1400 people, only 800 of whom are in the Headquarters building located in Eckernförde. The remaining 600 employees of E71 are located at various outstations. Two of these outstations of particular interest here are the Aschau Messtelle (for Aschau Ship Noise Range) and the Transducer Calibration Facility at the Grosser Plöner See (the Lake at Plön). The locations of both of these facilities are indicated in Figure 5-2.

The part of the internal organization of E71, pertinent to this Register, is shown in Figure 5-3.

This first entry for E71 will deal primarily with the Aschau Ship Noise Range. A second and separate E71 entry will describe the Calibration Facility at Plön.

In former years, a Naval Station shore facility at Helgoland was used for the calibration of transducers and hydrophones. Bad weather at this site, however, rendered the facility useless for all but about 30 days each year. As a consequence, this facility was abandoned for calibration purposes in favor of the new installation at Aschau.

At one time, funds were allocated to allow calibration work to be performed off the North Sea Platform with its deeper depth of 98 ft./30 m. Upon investigation, however, poor weather again threatened to curtail the number of measurement days obtainable. Furthermore, while it would be necessary to use a temporarily deployable array off the platform, the existence of severe tidal currents in the area are a hazard to any bottom mounted array of less than massive proportions. As a consequence of the above, the plan to use the North Sea Platform was never implemented.

The Aschau Range installation has proven to be very satisfactory and is heavily used by the German Navy, the navies of allied countries, and by German shipbuilders.

The water depth at the Aschau Range is relatively shallow, 65-85 ft./20-26 m. The bottom is sand overlain with about 1.2 in./30 mm. of mud.

Each individual hydrophone in the array is supported 3.28 ft./1 m. off the bottom on a tripod, in accord with NATO Standard #1136, concerning acoustic ranging. The hydrophones used are Brüel & Kjaer Type 8101 with preamplifier having a sensitivity (including preamplifier) of -184 dB//1 V/1 μPa/Hz. Figure 5-4 is an artist's rendering of the hydrophone arrangement.

The physical arrangement of the hydrophones, buoys, and mooring clumps on the Aschau Range is shown in Figure 5-5. The hydrophone pair in Site #2 directly on the track is used for localizing discrete sources within the vessel under test.

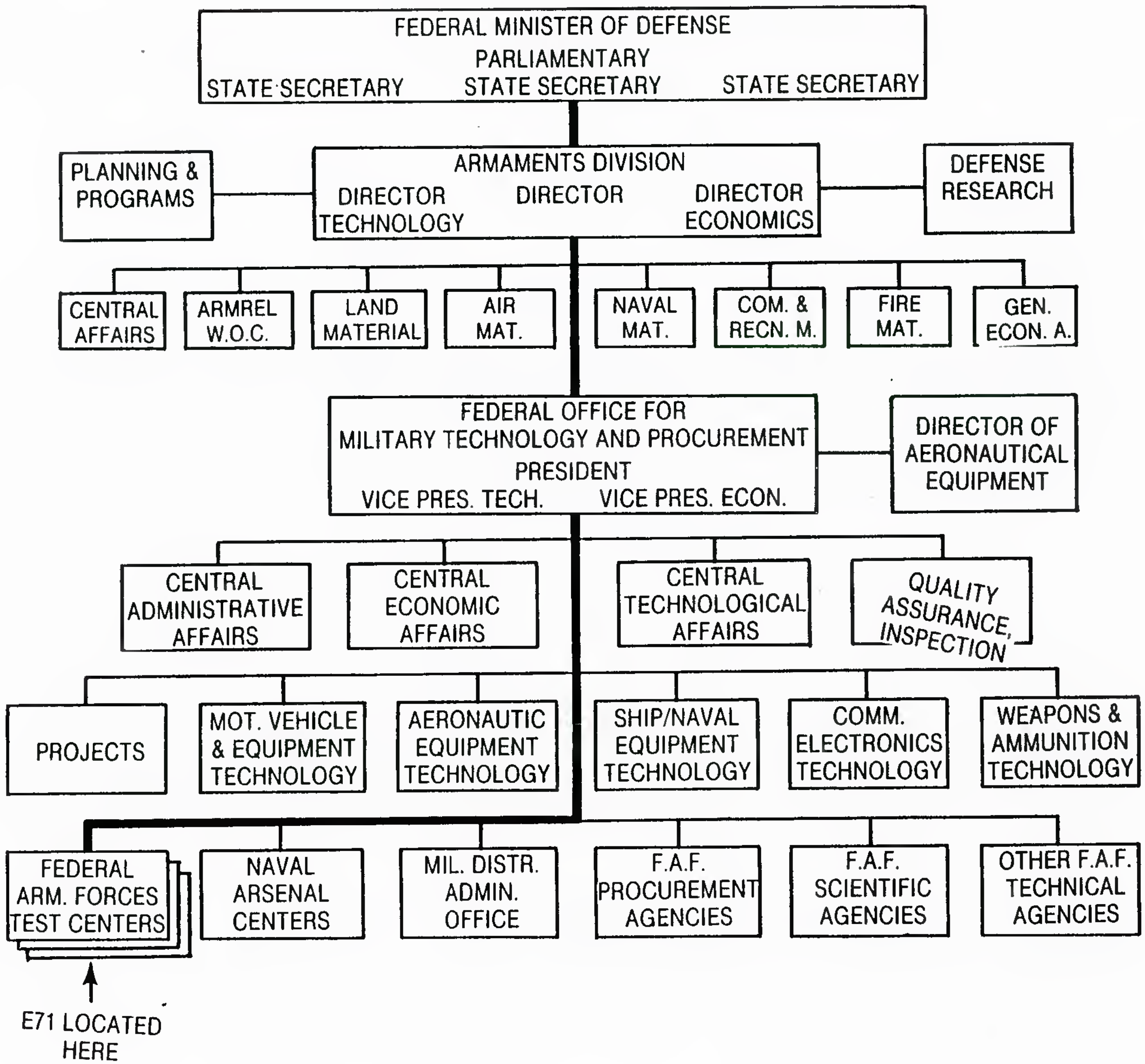

Figure 5-1. Organization of the German Federal Ministry of Defense

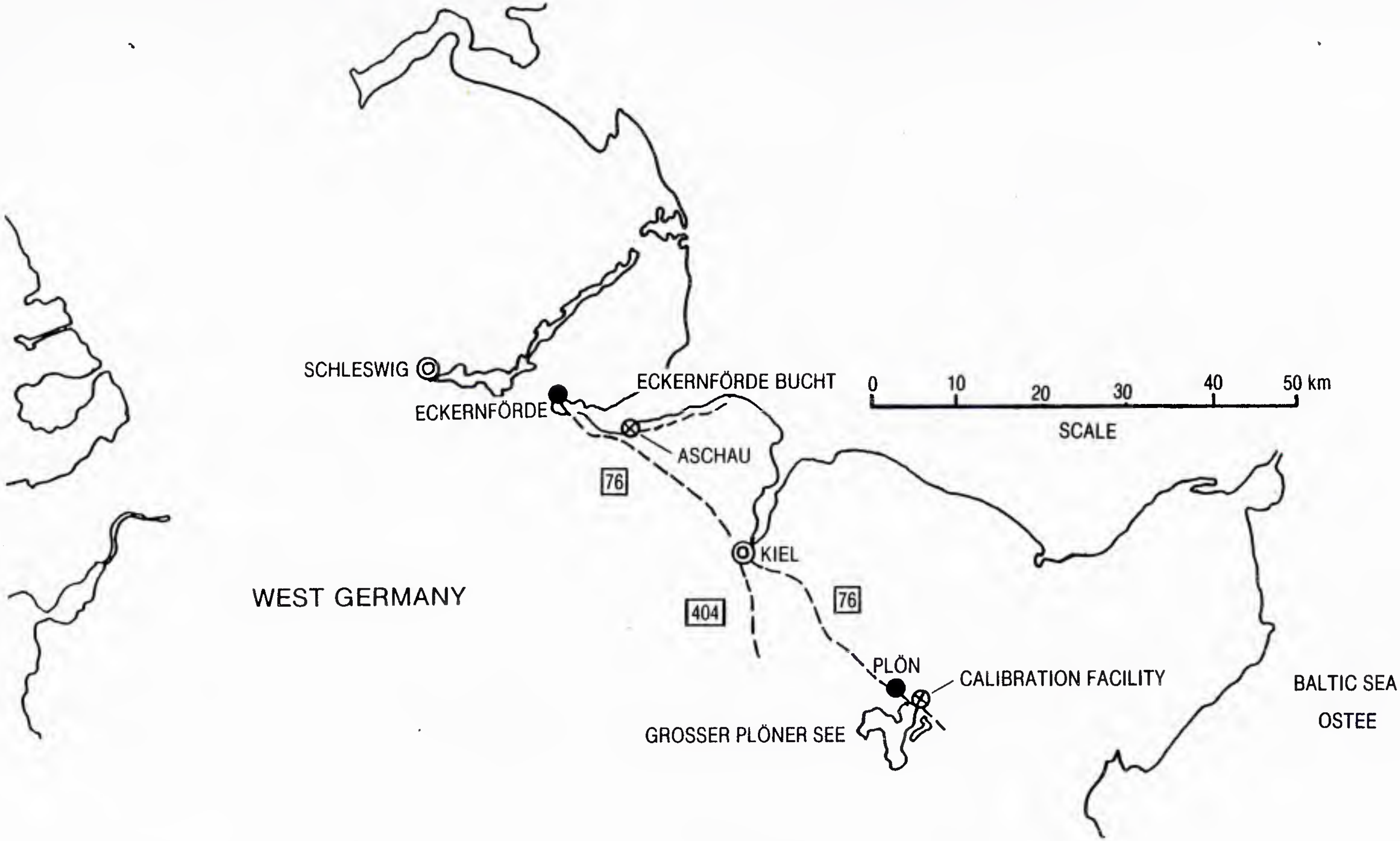

Figure 5-2. Locations of Erp. St. 71 -- Aschau and Plön

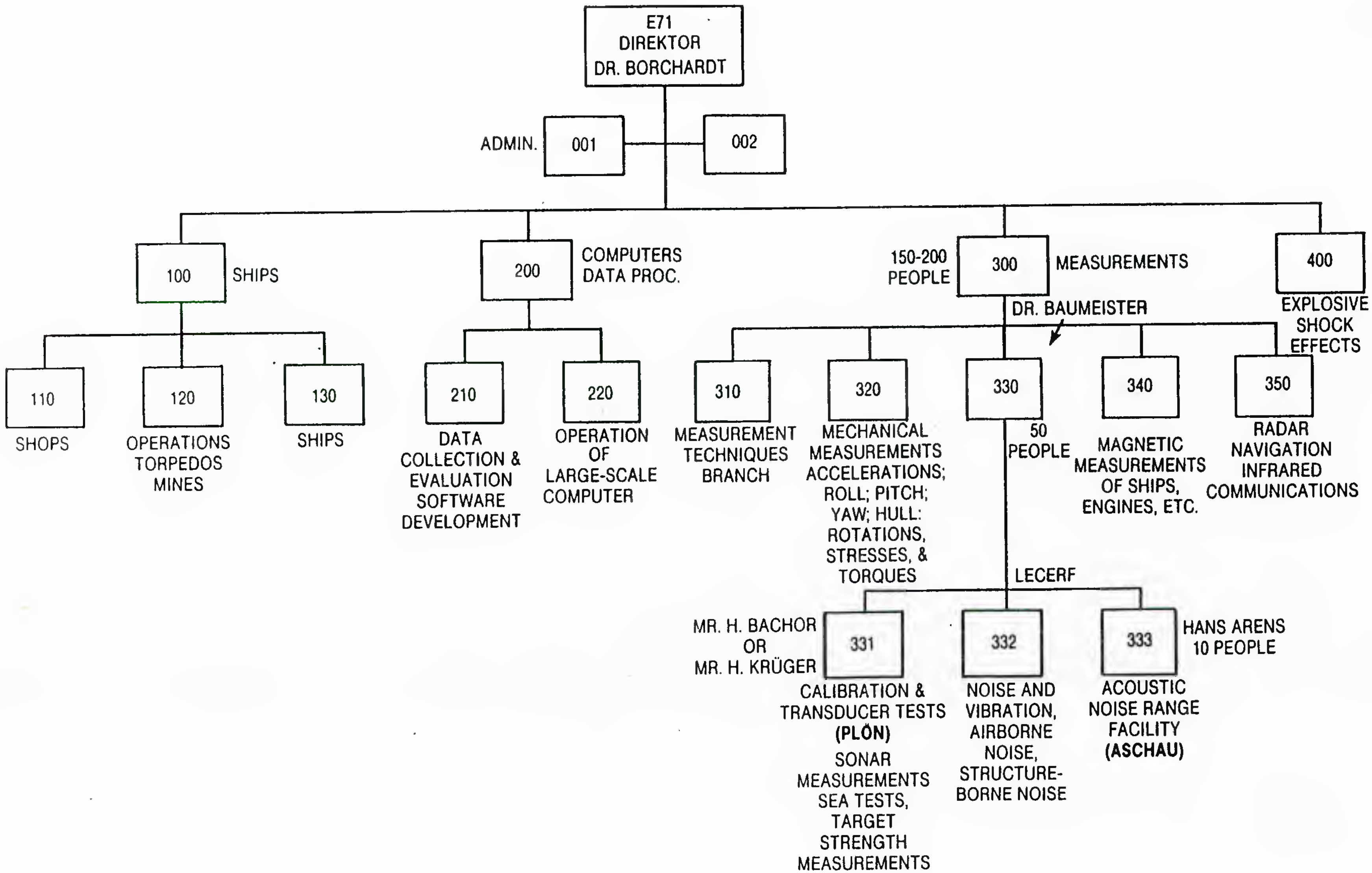

Figure 5-3. E71 Organization

Narrative Description (Cont'd):

Both submarines (at periscope depth) and surface vessels run the range on the track course indicated. Either type of vessel may be moored on the surface, normally at Site #2, for stationary measurements. For these tests, the vessel is secured in position with steel mooring lines attached to the four 25-ton/ 20,000-kg. concrete mooring blocks shown in Figure 5-5.

Submarines can also be suspended at mid-depth at a site (indicated in Figure 5-5) off the track but near the center of the range.

The maximum speed on the range is limited to 20 knots for large ships, while smaller vessels may exceed that limit somewhat. (Cavitation inception tests requiring high speeds are done in deeper water--generally at the Aamøy Range near Stavanger in Norway.)

One eight-hour day is required to make 15 to 20 runs for a single ship under test. A second day is normally required to make the stationary measurements, with the vessel in the 4-point moor. (In this configuration, each engine is run in turn. Each screw and each auxiliary are also operated one at a time to identify individual noise sources.)

Altogether, two days to a week are required to make a careful and complete ship measurement, depending on difficulties encountered.

In a normal year, approximately 100 ships are processed through the Aschau Range.

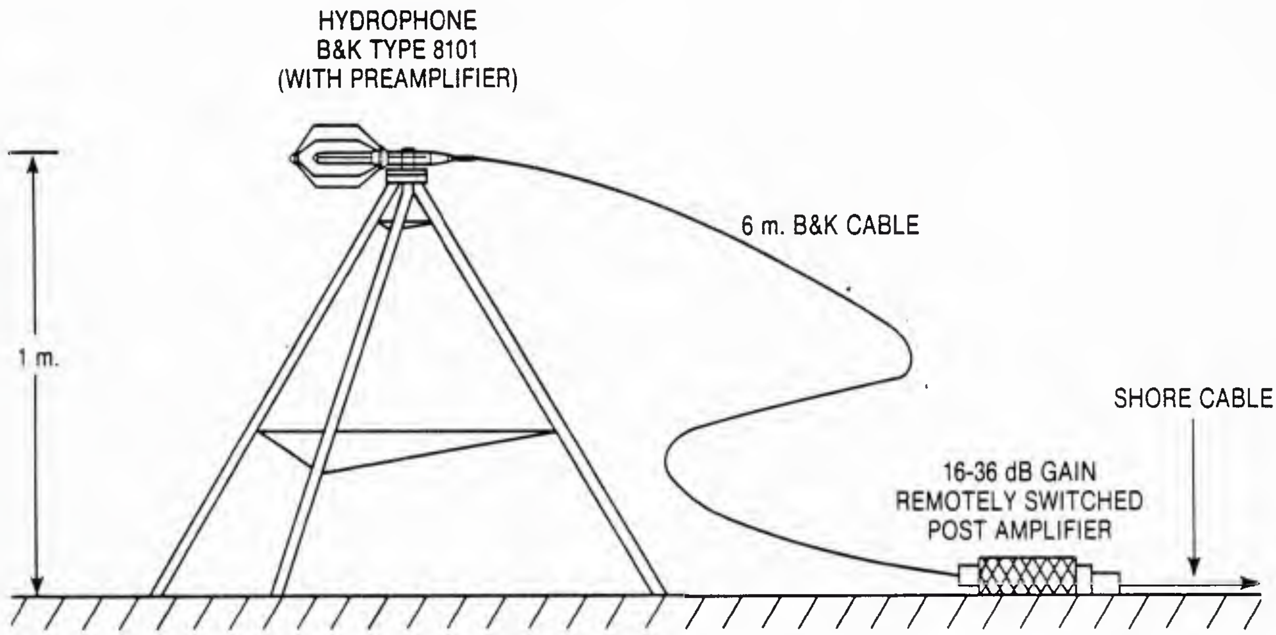

Figure 5-4. Individual Hydrophone Installation

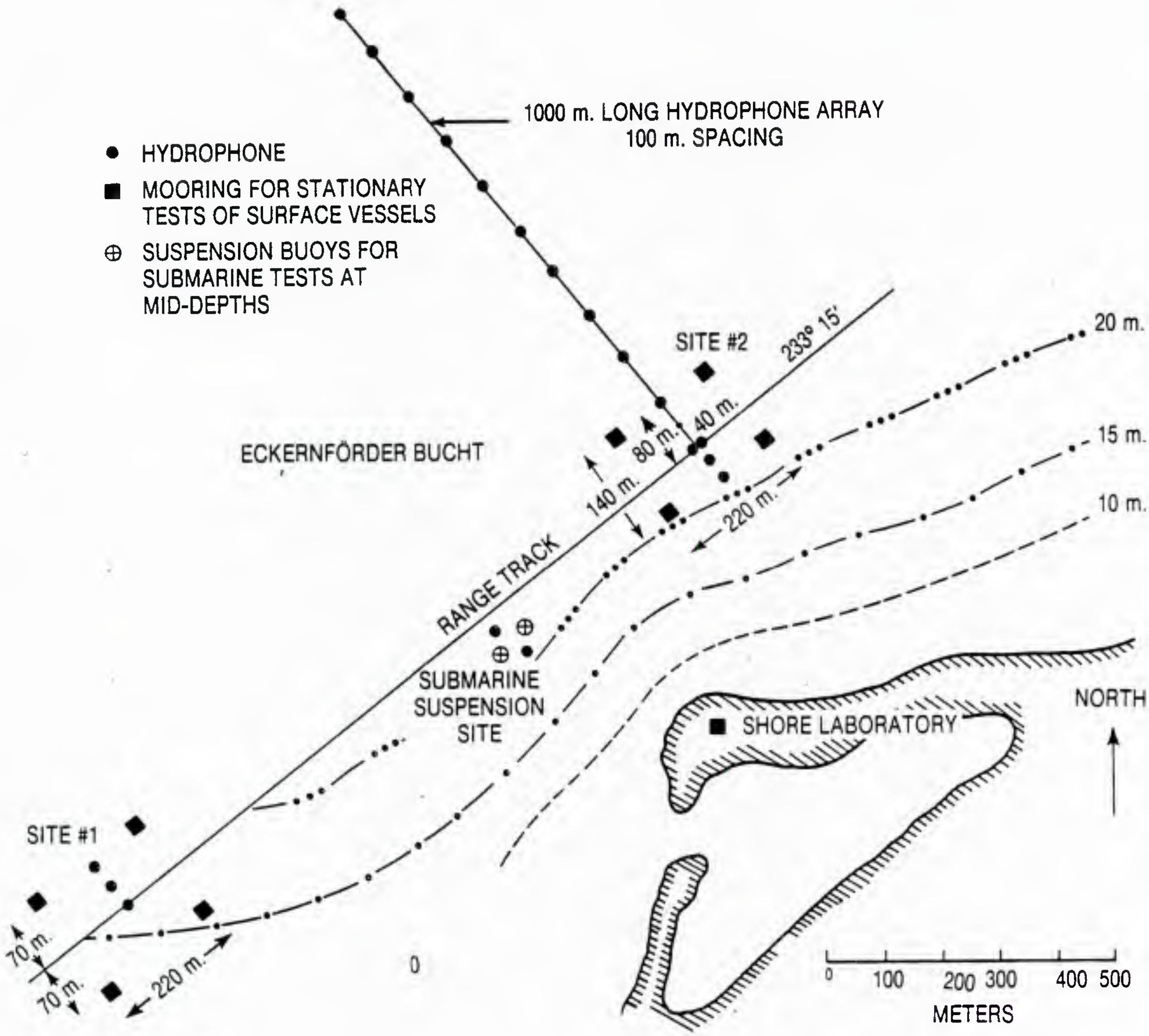

Figure 5-5. Aschau Ship Noise Range

Narrative Description (Cont'd):

Each hydrophone on the Aschau Range is provided with a separate cable over which the signals are brought ashore. The shore cables are lead-armored, six-conductor cables with a single shield over all six conductors. The shield is tied to the lead armor and is at sea ground.

A cable driver amplifier is located on the bottom, 20 ft./6 m. from the hydrophone. This amplifier has a gain of either 16 or 36 dB, which is remotely selectable from the shore laboratory using the amplifier DC power supply.

The shore cables are terminated in an impedance matching network in the shore laboratory to avoid reflections, and in the event of thunderstorms, the circuits are opened up at this point.

The signals from the matching network go directly into a post amplifier, a Hewlett-Packard Differential Amplifier with gain switchable from 0 to 40 dB in 10 dB steps and a bandwidth extending from 1 Hz to 100 kHz.

A block diagram of the data processing/recording system at the Aschau Range is given in Figure 5-6.

The Sabre IV Analog Tape Recorder is, as noted, a 14-track wide-band FM recorder. Two additional edge tracks are used to record time code and voice. The recorder is normally operated at either 15 ips or 30 ips continually whenever a vessel is on the Range. At the higher speed, the recording bandwidth extends from DC to 120 kHz. All analog magnetic tapes are stored permanently.

The one-third octave band level data are retained as well, in part for historical reasons. Such data has been gathered for a number of years, and such a body of data allows an examination of changes in the noise signature of individual vessels over long periods of time. Such a data bank also provides a good statistical base and allows for examination and comparisons of various classes of ships in terms of speed, frequency, etc. The one-third octave filter bands extend from 3.185 Hz to 80 kHz.

Although the averaging time for the one-third octave filter set is somewhat dependent on ship's speed, a 7-second averaging time is more or less standard for measurements of vessels underway on the Range. A 20-second averaging time is standard for the measurement of moored vessels.

To generate noise spectrum plots from these data, the one-third octave levels are reduced by 10 Log Δf (where Δf is .23 midband frequency). When tonals (frequency peaks) are detected in a set of data, the adjustment is not made to that band in which the tonal falls.

The GR 1925 one-third octave filter set operates on the broadband analog signals and generates a digital sequence. The GR 1926 Controller provides a weighting function control, allowing a selection of integration times between 1/8 to 32 seconds. The integration time used is normally 1.0 second.

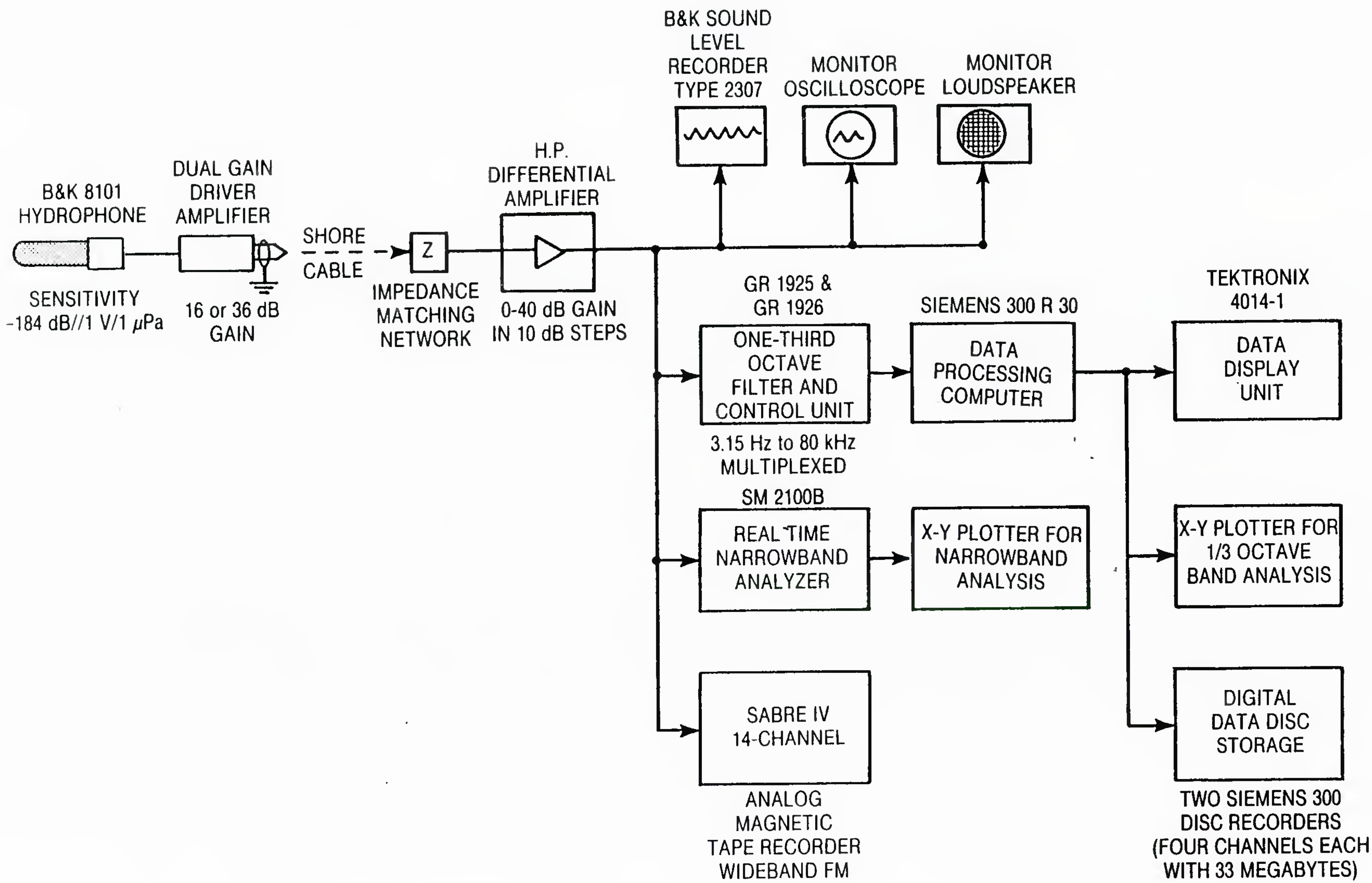

Figure 5-6. Block Diagram of Aschau Data Processing/Recording System

Narrative Description (Cont'd):

The integrated 1-second sample is read by the Siemann 300 R30 Computer and displayed on a Tektronix 4014-1 CRT Display. At the same time, the data are transmitted to the X-Y plotter and to the digital data disc storage. (See Figure 5-6.)

Two real-time (online) plots of the 1/3 octave data are generated; one from the hydrophone 262 ft./80 m. off the track line and one from the hydrophone on the track course directly under the vessel under test.

All programming for the computer is performed in-house; that is, by E71 personnel in the 310 group.

The SM-2100B Narrow Band Signal Analyzer is described as a "basic programmable" unit. It operates on the same broadband signal as does the one-third octave filter set, and is parallel with that system. The SM-2100B Narrow Band signal processing system includes a printer, a plotter, a keyboard, dual floppy disc drive, and a 64-kilobyte memory.

As a matter of routine, one plot for each run is made for the "customer" to take away immediately. This first plot represents the output of the hydrophones on the track course directly beneath the ship being measured.

Other instrumentation in the Range Laboratory includes:

- Time Code Generator
- Frequency Synthesizer
- Band Shift Translator (Federal Scientific)
- Phase Meter
- Variable Filter (Kronhite)
- Variable Filter (Telco)
- Siemens Digital Printer
- Overload Indicators (at outputs of post amplifiers)

The Laboratory is well supplied with oscilloscopes, voltage meters, and the other routine but necessary measurement instrumentation.

The Laboratory also has a communications console which includes VHF and UHF ship circuits as well as a 30-kHz single-sideband underwater telephone system.

Generally, theodolites are not used during the ship measurements unless specifically requested. Permanent theodolite stations do exist outside on the Laboratory grounds, however, and if necessary, another group from E71 provides the service. When theodolites are used, synchronizing pulses are transmitted to both theodolite sites by VHF circuit. Signals are returned by VHF circuits to the master station at the Laboratory and then by cable to a paper punch in the Laboratory for recording.

Vessel alignment on track is usually accomplished by visual means. Much of the testing of submarines occurs at night, however, and at periscope depth, so standard Navy radar on the periscope is generally used at such times.

Narrative Description (Cont'd):

Real time recordings of submarine transient signals are performed on request only. Signals are digitized with a 12-bit A/D converter and the digital computer writes the transient signals onto magnetic discs at a maximum sampling rate of 150 kHz. The digitized data are windowed and Fast Fourier Transformed to provide plots of the transient frequency spectra.

In addition, demodulation equipment and techniques are regularly applied to make frequency line analyses of the radiated noise from all submarines and from selected (one from each new class) of surface ships.

It is planned that a data communication cable be installed between the computer in the Aschau laboratory and the home laboratory in Eckernförde. The data would be scrambled at Aschau prior to transmission.

Currently, the major computers in the Eckernförde Laboratory at two Siemens 7751 CPUs under the cognizance of the group responsible for software development (210--see Figure 5-3) and data collection and evaluation.

The shallow depth and the proximity to shore does impose an upper limit on ship speed when running the range, particularly for large vessels, of about 20 knots.

For those cases where very large vessels are to be measured and/or higher speeds are necessary, the deeper Aamøy Range off Stavanger in Norway is used. (The German Ministry of Defense has had a contract for use of this Range 45 days per year since 1975.) The Aamøy Range is approximately 360 ft./110 m. deep with a rocky bottom. It is fairly well shielded from high seas but it suffers from interference from traffic noise, necessitating frequent nighttime measurements. In using the Aamøy Range, E71 personnel utilize the array on the bottom and the cable termination in the Laboratory building, but bring their own data recording and processing equipment and perform their measurements themselves.

E71 also has a very quiet mobile hydrophone system which can be transported to any platform desired. It is maintained in a ready condition and is used mainly for special acoustic purposes. It has been used for torpedo propeller noise tests at Keyport and off Newport.

Date of this Summary
2 July 1985

Facility Name: Erprobungsstelle 71 der Bundeswehr: Messtelle Plön

Location: The facility is 41 mi./65 km. from Eckernförde, on the Grosser Plöner See, near the town of Plön. (Plön lies 15.6 mi./25 km. southeast of Kiel on Route 76.) The facility and access to the measurement barge is on the grounds of a Naval Training Center (Petty Officers' School) on the north shore of the Grosser Plöner See, approximately 1.2 mi./2 km. east of Plön.

Cognizant Organization: Erprobungsstelle 71 der Bundeswehr

Facility Functional Name: Plön Calibration Facility

Major User(s): German Navy, FWG in Kiel, German shipyards, and some commercial activities

Technical Areas Supported: Noise generation by divers' equipment and by submersibles, sonar array measurements, hydrophone and transducer calibration and measurement techniques, and target strength studies

Unique Features: Barge on lake with deep water (90 ft./27 m.) and soft bottom. Low frequency (8-125 Hz) in-air calibration capabilities.

Significant Equipment Available: A fully instrumented Measurement Hut (Messhaus) on pilings 426 ft./130 m. offshore. All aluminum barge (Prahm) approximately 3280 ft./1000 m. offshore. A 2.5-ton/2273-kg. hoist on shore and a 2.5-ton/2273-kg. hoist at the Hut. A 0.5-ton/455-kg. handling capability on barge. Several standard sources: J9, J11, J13, TR 16, 23, 25, and 15, and B&K 8100 (as well as B&K 8101 Receiving Only Hydrophone). An in-air hydrophone low-frequency calibration tube and an in-air pistonphone.

Local Environment: Quiet lake. Ice-covered from January to March. (Can do hydrophone calibrations in winter using air bubbler in well in Hut to keep the well ice free.) Ice in winter 6-8 in./15-20 cm. thick (occasionally as thick as 20 in./50 cm). Lake bottom is sand overlain with 6 in./15 cm. of soft mud at Hut and 3.3 ft./1 m. of mud under barge. Water depth is 32.8 ft./10 m. under Hut and 92 ft./28 m. at barge, 3280 ft./1000 m. from shore.

Future Plans for Facility: New, larger rotator and shaft on barge. Plan to build a 1/10 scale submarine with which to conduct target strength studies.

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Local Contacts: E71 Direktor Borchard
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Mr. H. Liebold
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232 Plön-Ruhleben
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Narrative Description: The Plön Calibration Facility (Plön Messtelle) is part of the E71 organization and resides in the 331 group under Mr. H. Bachor and Mr. H. Krüger. (See Figure 5-3 in the Aschau entry for organizational chart.)

Physically the facility is located on the north shore of the Grosser Plöner See about 1.2 mi./2 km. east of Plön. (See the map given in Figure 5-2 of the Aschau entry.)

The Plön Calibration Facility is the sole calibration site for the German Navy and for German laboratories (as FWG in Kiel) involved in underwater acoustics, and for German shipyards. The facility receives considerable work from German commercial activities as well.

The kinds of work generally performed at the Plön Facility are:

1) Transducer/hydrophone calibrations

2) Examinations of noise levels of divers' equipment (breathing apparatus, valves, etc. Concern relates to divers' work with explosive mines.)

3) Submersibles -- noise levels, target strengths

4) Sonar arrays -- transmit/receive directivity patterns (no specific dome work)

5) Transmissivity measurements (reinforced rubber)

6) In planning: target strength measurements using 1/10 scale model submarine, with removable conning tower and air-filled pipes simulating periscope

The Plön Calibration Facility has a permanent staff of six people including two engineers, one technician, two mechanics, and a secretary.

The two mechanics maintain and operate a well-equipped mechanical workshop.

The two major components of the Plön Facility are a Measuring Hut (Messhaus) on pilings 426 ft./130 m. offshore and a floating barge (Prahm) approximately 3280 ft./1000 m. offshore. Both stations are reached by boat.

The Measurement Hut, which stands 5 ft./1.5 m. off the water in 32.8 ft./10 m. of water, is shown in Figure 5-7.

The Hut is configured so that a small boat transferring equipment to or from shore can go directly into the Hut to a point beneath a 2.5-ton/2273-kg. hoist for loading and unloading.

Narrative Description (Cont'd):

A horizontal boom 65.6 ft./20 m. long (not shown in Figure 5-7) extends out from one end of the Hut and is supported at the far end by a tripod of pilings to provide the source to receiver separation desired. The water depth at the far end of the boom is 50 ft./15 m.

There is no rigid or controllable shafting in the Hut and elements to be tested are lowered into the water and suspended freely. Within the Hut proper, the maximum source to receiver separation is 23 ft./7 m.

Calibration signals are either pulsed sine waves or CW noise transmissions.

The pulse sine wave transmissions utilize a 1 millisecond pulse length which allows for 5 amplitude peaks at 1000 Hz. One-millisecond-long pulsed sine waves are used at frequencies from 1 kHz to 150 kHz. (The system is driver limited at 200 kHz.)

Broadband CW noise measurements are used at lower frequencies, with a lower limit of 100 Hz.

Instrumentation in the Hut includes:

Brüel & Kjaer Type 2636 Measuring Amplifier
Includes IEC/IEEE Interface for digital readout and control -- used with an HP PC 26. Includes preamplifier input.

Figure 5-7. Measurement Hut

Narrative Description (Cont'd):

Brüel & Kjaer Type 2610 Measuring Amplifier
Includes preamplifier input

Brüel & Kjaer Type 2313 Graphic Level Recorder

Brüel & Kjaer Type 2713 Power Amplifier (100 VA)
For driving reactive loads (underwater sound projectors)

Brüel & Kjaer Type 1027 Sine-Random Generator
Sine and narrow band random noise 2 Hz-200 kHz, used with gating

Wagner Kerr Industries Capacitance Bridge

Aktives 4002 Variable Band Pass Filter

The Hut is well supplied with such miscellaneous but necessary monitoring instrumentation as oscilloscopes, voltmeters, and speakers.

The reason that the gating is required with the above Sine-Random Generator is not due to bottom reflections (6 in./15 cm. of soft mud over sand) but rather is due to the proximity of the support pilings.

There are, in addition, two systems dedicated to the special problems of diving equipment. These systems each include a General Radio One-Third Octave Filter Bank covering the frequency range from 3.15 Hz to 80 kHz, interfaced with the Hewlett-Packard PC 26.

A variable air pistonphone is available at the Plön Facility, and is used for calibrations over the frequency range from 20 to 500 Hz.

Another in-air calibration device is constructed with a loudspeaker as source mounted at the bottom of a large cylinder and makes use of the comparison (with a known reference element) method to calibrate an unknown hydrophone. (See Figure 5-8.) This system is used at frequencies from 8 to 125 Hz.

The above system has been checked by calibrating units which have been calibrated elsewhere in water using other procedures and equipment, with good results.

The second major component of the Plön Facility is the all-aluminum floating barge (Prahm). The barge is moored about 3280 ft./1000 m. from shore in a water depth of 92 ft./28 m. The bottom in that area consists of 3.3 ft./1 m. of mud over sand. The main features of the barge at Plön are diagrammed in Figure 5-9.

The receiving standard reference hydrophones on the barge are a B&K Type 8100 (reciprocal) hydrophone and a B&K Type 8101 (receive only) hydrophone with preamplifier.

The standard sources used on the Plön Barge include three Chesapeake (now Gould) projectors: the J-9, the J-11, and the J-13. Four Massa types are also used: a TR-16, TR-23, TR-25, and a TR-55.

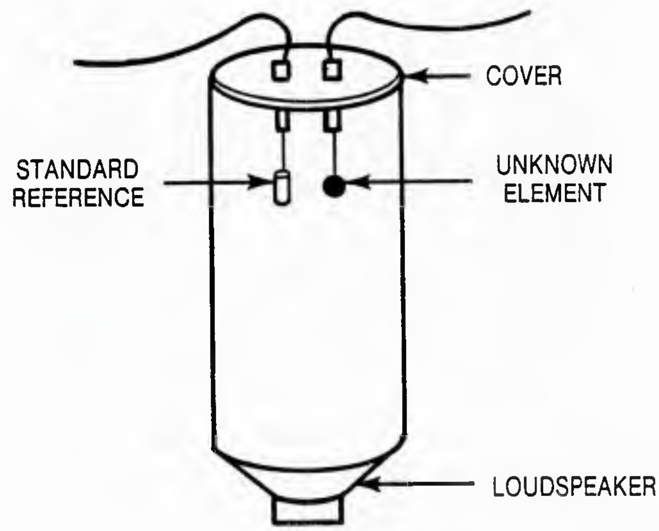

Figure 5-8. Low Frequency In-Air Calibration System

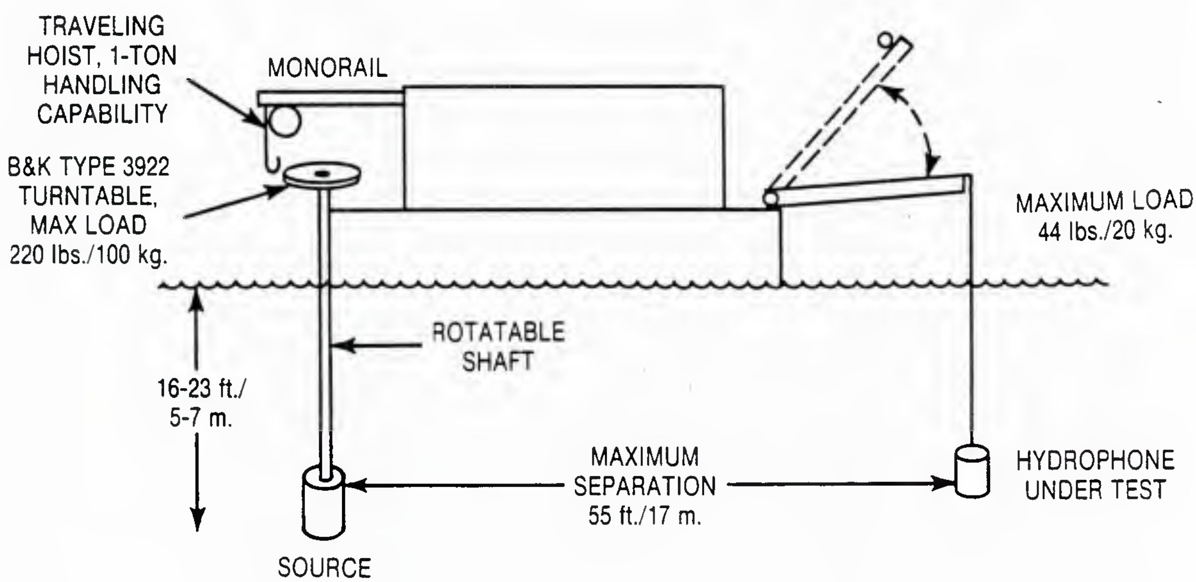

Figure 5-9. All Aluminum Barge at Plön Calibration Facility

Narrative Description (Cont'd):

In general, measurement instrumentation is transported from shore to the barge as needed and very little is permanently retained onboard.

The equipment which is permanently available onboard includes two fixed installations: a driver amplifier monitor group and a receiving hydrophone group. These two installations are shown in Figure 5-10.

The barge is supplied adequately with miscellaneous portable instrumentation as oscilloscopes, voltmeters, and signal generators.

Power to the Hut includes:

50 Hz, 15 kVA
2 Ø, 220 VAC
3 Ø, 380 VAC

Power to the Barge (when moored) includes:

50 Hz, 3 kVA
2 Ø, 220 VAC
3 Ø, 380 VAC

If the Barge is not moored at the normal cable termination point, then a generator or batteries are used to supply whatever power is required.

In general, the Lake (Grosser Plöner See) is ice-covered from January through March, and in a severe winter, the ice may reach a thickness of 20 in./50 cm. All measurements, with the exception of hydrophone calibrations, are suspended in January. The hydrophone calibration measurements which must be accomplished during the winter are performed in the Hut. An air-bubbler system is used to keep the water surface sufficiently ice-free in the well inside the Hut to allow the necessary tests.

Plans for the Plön Facility include acquisition of new and larger (heavier duty) shafting and for a new and larger rotator. The new rotator will probably be a Scientific Atlanta unit.

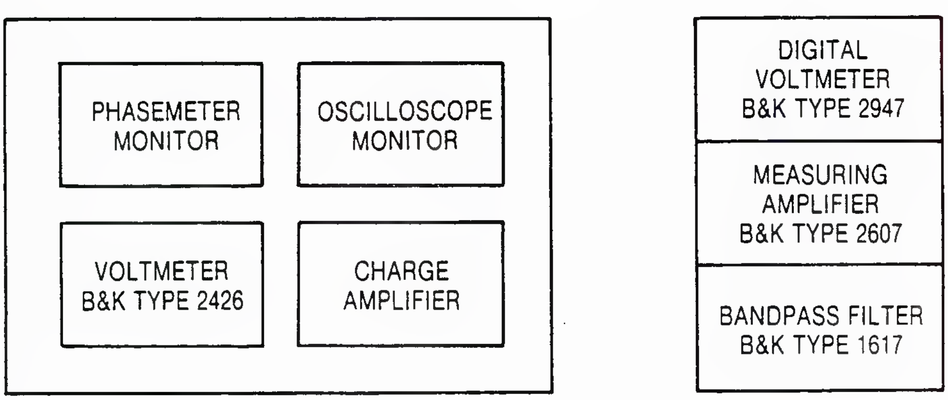

Figure 5-10. Driver Amplifier Monitor Group and Receiving Hydrophone Group

Narrative Description (Cont'd):

There are also plans to complete construction of a 1/10 scale model submarine which will have removable conning towers and will include air-filled tubing in the simulated periscope.

The model submarine is to be used in target strength/echo ranging studies and will be lowered from its own moored platform, 985 ft./300 m. away from the source on the barge in 98.5 ft./30 m. of water.

Date of this Summary
4 July 1985

Facility Name: Fraunhofer-Forschungsgruppe für Hydroakustik (FHAK)

Location: On Waldparkstrasse 41 in Ottobrunn, 7.5 mi./12 km. southeast of München or Munich center.

Cognizant Organization: Fraunhofer Gesellschaft (FhG)

Facility Functional Name: FHAK Hydroacoustic Laboratory

Major User(s): German Ministry of Defense (MOD)

Technical Areas Supported: Transmissivity and reflectivity studies, structure-borne noise studies, propulsion noise studies

Unique Features: A very well equipped facility on a quiet lake (Ammersee) with a self-propelled double pontoon barge, "Structura," for handling and testing (noise) models up to 4400 lb./2000 kg. on Ammersee.

Significant Equipment Available: All shop facilities are available in Ottobrunn. A 5-ton/4545 kg. planing boat, "Vitessa," on Ammersee; "Structura," as described above on Ammersee; "Silenta," a catamaran-type research vessel on Ammersee. The computer in the central office in Ottobrunn is a DEC PDP-11/23+ and the computer at Ammersee is a DEC PDP 11/34.

Local Environment: FHAK central office and shops are in Ottobrunn, a suburb of Munich, in a fairly busy industrial area with considerable traffic. Nearly all the actual acoustic work is done at the field station on Ammersee, a secluded and very quiet lake.

Future Plans for Facility: Probable move of entire operation eventually, from Ottobrunn to Ammersee.

Facility Mailing Address: Fraunhofer-Forschungsgruppe für Hydroakustik
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At above address
Tel: Int. Oper. + 49 89 609 7871

Contact for Access/Scheduling: Dipl.-Ing. K. Albrecht, Director, as above

Narrative Description: FHAK is a member institute of the Fraunhofer-Gesellschaft (FhG), a company which incorporates 32 technical institutes throughout West Germany.

The central office for FhG is located in München or Munich and FhG employs some 3000 people of whom 1500 are technical professionals. The mission of the 32 institutes differ widely; from specialized studies of physics and chemistry to

Narrative Description (Cont'd):

studies of transportation, solar energy, and explosives. All of the institutes are oriented toward the support of industry and/or defense.

FHAK, the Fraunhofer-Forschungsgruppe für Hydroakustik, and the smallest of the 32 institutes, is located in Ottobrunn, a suburb of München or Munich, 7.5 mi./ 12 km. south-east of the center of the city and is easily accessible by rail, bus, or taxi.

FHAK was founded in 1965 and is now under the direction of Dipl.-Ing. K. Albrecht. FHAK employs 31 people in Ottobrunn, of whom 11 are research scientists. The specialties of the technical staff are again varied: theoretical physics, experimental physics, hydraulic engineering, acoustics, marine architecture, fluid dynamics, etc.

The Institute is engaged almost entirely in applied research, with the main thrust in the direction of ship noise silencing. Particular areas of interest are propulsion noise (propellers, cavitation), structure-borne noise (engine, hull, rudder), and hydrodynamic noise sources (flow, flow-induced noise), and the radiation of such sounds into the water. Noise in terms of habitability is of only minor concern.

The vessels with which the Institute is concerned are almost entirely of three types: frigates, conventional submarines, and mine hunting/sweeping vessels.

Some propeller design work is done here, in conjunction with the Hamburg Model Basin.

FHAK is 60% direct funded by the Ministry of Defense (MOD) and 30% supported by project earnings also funded by MOD. Another 5% to 10% of funding is through commercial/industrial projects.

The majority of the FHAK experimental acoustic work is performed at the field station on the shore of Ammersee, or Lake Ammer, just outside of the town of Herrsching. Herrsching is approximately 24 mi./40 km. southwest of central München or Munich.

The station is very well equipped in terms of general instrumentation, including the necessary meters, recorders, oscilloscopes, etc. Specialized facilities used for specific programs are described in the following pages.

The computer at the Lake Ammer or Ammersee Station is a DEC PDP 11/34 and the computer at the Institute in Ottobrunn is also a DEC PDP-11/23+.

The mechanical and electrical shop facilities are all located in Ottobrunn. There are five people in the machine shop and three in the electrical shop. All splicing and molding operations are performed in these shops. The low noise preamplifiers in use at the experimental/measurement facility were designed and constructed here, including electronics and waterproof containers.

It should be noted finally that there is a long term plan to consolidate the Institute in a new building to be constructed at the site on Lake Ammer or Ammersee.

Narrative Description (Cont'd):

The acoustic experiments and the associated facilities at the Ammersee Test Station are of three types:

1. Acoustic Transmissivity and Reflectivity Studies (dome materials studies),
2. Structure-Borne Noise (hull, rudder, and other hull appendages; precise scale model studies), and
3. Propulsion Noise (propeller noise, cavitation, and other propulsion noise).

Descriptions of the above-mentioned facilities are given on the following pages.

Date of this Summary
4 July 1985

Facility Name: "Structura"

Location: On Ammersee or Lake Ammer, near the town of Herrsching, 25 mi./40 km. southwest of München or Munich in southern West Germany (Bavaria).

Cognizant Organization: Fraunhofer-Forschungsgruppe für Hydroakustik (FHAK), a member institute of the Fraunhofer-Gesellschaft (FhG)

Facility Functional Name: Double pontoon barge

Major User(s): FHAK

Technical Areas Supported: Ship noise reduction, materials transmissivity/ reflectivity studies

Special Programs Supported: 1. Precise scale-model ship structure-borne noise studies; 2. Dome materials transmissivity/reflectivity studies

Unique Features: Handling system for submerging large scale models of ships up to 23 ft. long x 4.1 ft. wide/7 m. long x 1.25 m. wide, to scaled depths and for rotating up to four measurement hydrophones spaced along the length of the model, from one beam down beneath the model and up to the other beam with a radius arm of 9.8 ft./3 m. See Figure 5-11.

Significant Equipment Available: Handling system (includes two 2200-lb./1000-kg. hoists) for lowering an assembly including test panel, source transducer, and receiving hydrophones to a depth of 262.4 ft./80 m., used for measuring transmissivity and reflectivity of materials; DEC PDP 11/34 computer on shore--compatible with PDP-11 in Ottobrunn used for data analyses, analog to digital conversion capability, pulse code modulated data telemetry to a DEC PDP; crane with 2.5 tons/2000 kg. capacity; and two BMW inboard/outboards for propulsion.

Local Environment: Quiet lake (rural) with very limited boating/fishing. The lake is approximately 10 mi./16 km. long and 3.7 mi./6 km. wide. The depth is 262 ft./80 m. at the deepest and has a central channel 197 ft./60 m. deep or greater, which is 0.9 mi./1.5 km. wide and 3.1 mi./5 km. long. The bottom has 49 ft./15 m. of soft mud overlaying 490 ft./150 m. of gravel over bedrock.

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Tel: Int. Oper. + 49 89 609 7871

Contact for Access/Scheduling: Dipl.-Ing. K. Albrecht, Director, as above

Narrative Description: "Structura" is a 20-ton/18182-kg. double pontoon barge, 42.6 ft./13 m. in length with a beam of 24.7 ft./7.5 m.

It is equipped with two BMW inboard/outboard propulsion systems, used solely for transport from the shore to a fixed measurement site on the lake. The barge is not normally used for underway measurements.

"Structura" is used mainly in the prosecution of two programs:

1. The use of scale model ships in the study of structure-borne radiated noise, and

2. Transmissivity/reflectivity studies of materials such as sonar dome materials.

In the first case, an accurate model of a ship to be analyzed is used. Currently, a 1/8-scale model of a Patrol Boat, carefully constructed and containing all the essential internal ribs and supports is in use. When the ship model is in the water, engine noise is simulated by B&K shakers installed at the engine locations and the noise from each screw is simulated by a USRL Orlando J-9 mounted in the screw position(s).

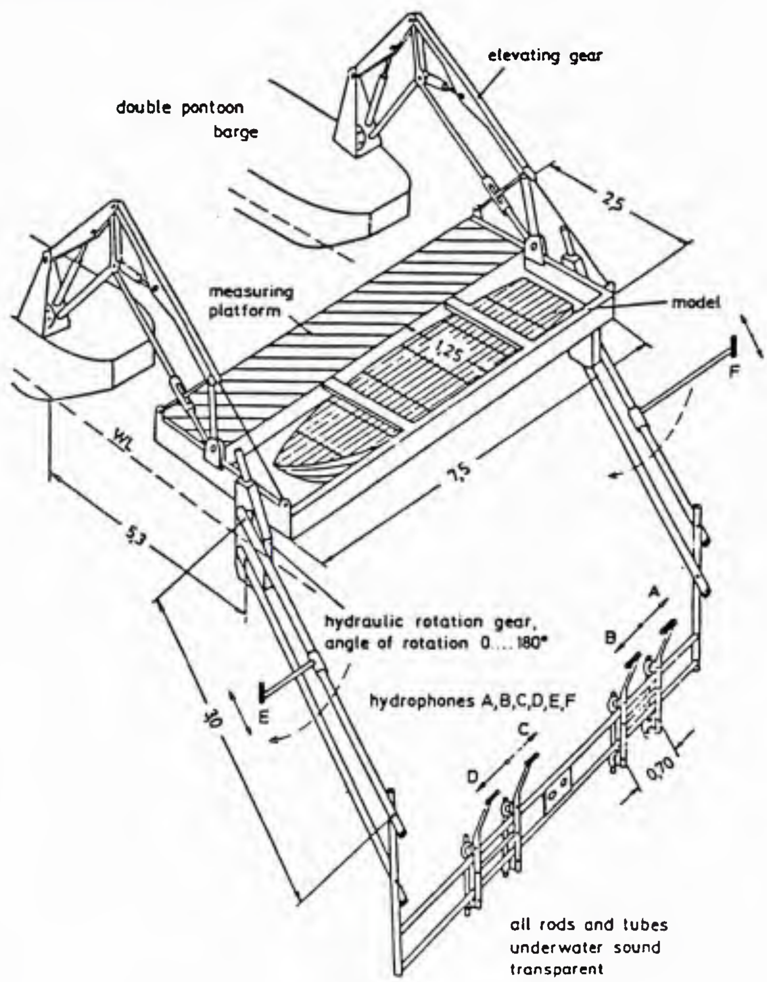


Figure 5-11. STRUCTURA

Narrative Description (Cont'd):

The 19.7-ft./6-m. long model is lowered into the water by the 2.5-US ton/ 2000-kg. crane and the measurement platform is then lowered over the model so as to hold it in position. See Figure 5-11. The barge is moved to the measurement site (with the hydrophone rotation arms raised) and is then moored. The model is depressed to the proper depth with the constraining bars of the platform forcing it down.

With the engine and/or propeller simulation sources energized, the hydrophone array can be rotated through the acoustic field beneath the model continuously or to whatever specific angles are required. (See Figure 5-11.) Data from all hydrophones can be monitored onboard "Structura" as desired. The four hydrophones along the length of the model can be adjusted fore and aft to examine the entire field in whatever detail is necessary. Hydrophones (E) and (F) in Figure 5-11 permit an examination of the radiated field off the bow and stern.

Dr. Wittek is the Principal Investigator on this program.

The second program for which "Structura" is used is a study of acoustic transmission and reflectivity losses at panels of various materials as a function of pressure.

A large jig has been constructed which supports the panel under test, the acoustic source and the receiving hydrophone all in a fixed geometry (Figure 5-12).

Two 2200-lb./1000-kg. hoists provide the capability for handling and lowering the jig to the desired depths. (Pressure is varied by changing depth.)

The source projector used for these transmissivity/reflectivity tests is an F33 from Actran Systems in Orlando (similar to the unit built by USRL Division of NRL for US Navy facilities) which can be used at frequencies up to 100 kHz.

The receiving hydrophones, placed two on each side at the test panel, are Atlantic Research (now Celesco) LC-32 hydrophones. The hydrophone/preamplifier/cable arrangement is shown in Figure 5-13.

The frequencies currently being examined under this program lie between 3 kHz and 50 kHz. Transmissions are pulses 1.0 millisecond long, transmitted at a rate of 7 pulses per second, each pulse being at a different frequency and progressing from 3 kHz to 50 kHz.

The signal generator is a Brüel & Kjaer Type 1027 Sine-Random Generator.

The signals received from the hydrophones are detected at an FHAK-built Pulse Detector and those DC outputs are modulated at a Pulse Code Modulator and transmitted ashore via radio to the DEC PDP-11/34 data acquisition and reduction system.

Dr. Brebeck is the Principal Investigator on this program.

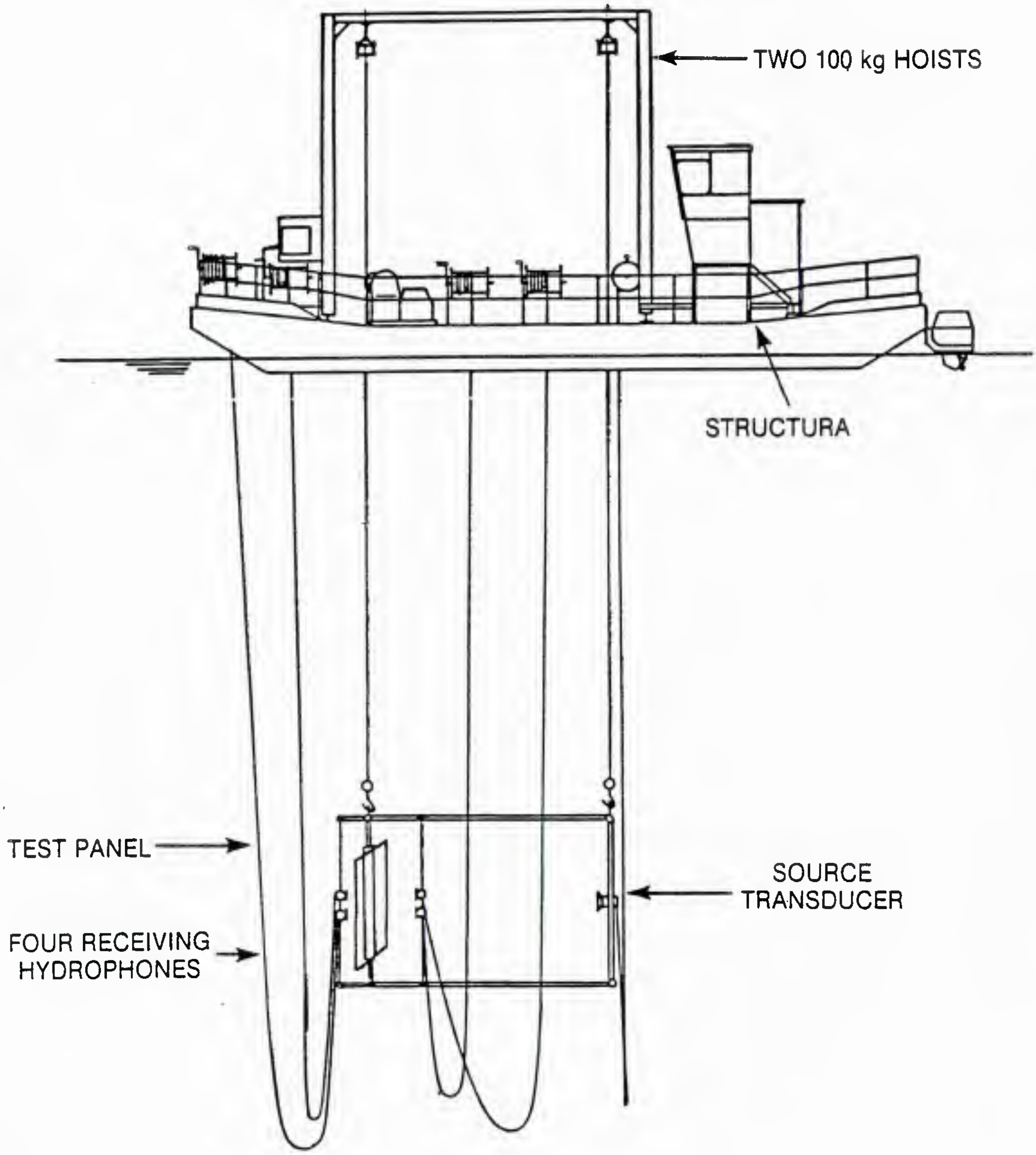


Figure 5-12. Arrangement for Measuring Reflectivity and Transmissivity of Test Panels

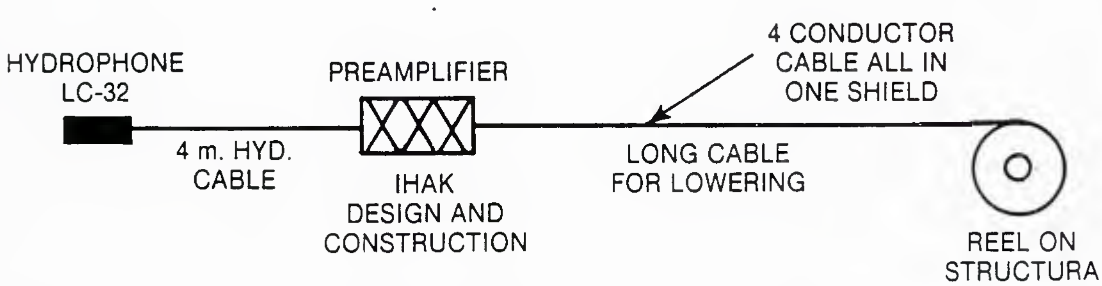


Figure 5-13. Hydrophone/Preamplifier/Cable Arrangement

Date of this Summary
4 July 1985

Facility Name: "Vitessa"

Location: On Ammersee or Lake Ammer, near the town of Herrsching, 25 mi./ 40 km. southwest of München or Munich, Germany.

Cognizant Organization: FHAK, a member institute of Fraunhofer-Gesellschaft (FhG)

Facility Functional Name: Research vessel (5-ton/4545-kg. planing boat)

Major User(s): FHAK

Technical Areas Supported: Propeller cavitation noise investigations

Unique Features: Five-ton/4545-kg. planing boat designed for cavitation noise experiments in open water. Boat planes at 30 kt./15 m/s., has gliding speed (very quiet) of about 10 kt./5 m/s. Driven by twin waterjets powered by two 180 kW gasoline engines. Plexiglass window in bottom in test area.

Significant Equipment Available: Propeller dynamometer, stroboscopes, high speed camera, seven-track magnetic tape recorder, radio position indicator (RALOG)

Local Environment: Quiet lake (rural) approximately 16 km./10 mi. long and 3.7 mi./6 km. wide. Maximum depth is 262 ft./80 m. Lake has a central channel 3.1 mi./5 km. long and 0.9 mi./1.5 km. wide, with a depth of 197 ft./60 m. or greater. The bottom has 49 ft./15 m. of mud over a layer of gravel 490 ft./150 m. thick which is directly over bedrock.

Future Plans for Facility: Continue propeller cavitation noise studies and propeller/wake interaction studies. Construct a cavitation noise measurement range on Ammersee or Lake Ammer.

Facility Mailing Address: Fraunhofer-Forschungsgruppe für Hydroakustik
Waldparkstrasse 41
D-8012 Ottobrunn
Federal Republic of Germany

Local Contacts: Dipl.-Ing. K. Albrecht, Director
At above address
Tel: Int. Oper. + 49 89 609 7871

Contact for Access/Scheduling: Dipl.-Ing. K. Albrecht, Director, FHAK, as above

Narrative Description: VITESSA is a 5-ton/4545-kg. planing boat designed for cavitation noise experiments in open water. The boat is limited to 30 kt./15 m/s. on the lake, which is the planing speed. The vessel "gliding speed" is 10 kt./5 m/s., at which speed it is very quiet.

Narrative Description (Cont'd):

Length	29.5 ft./9 m.
Beam	10.5 ft./3.2 m.
Draft	2 ft./0.6 m.

The vessel is provided with three 180 kW engines, two for the twin waterjet propulsion drive and one for the test propeller.

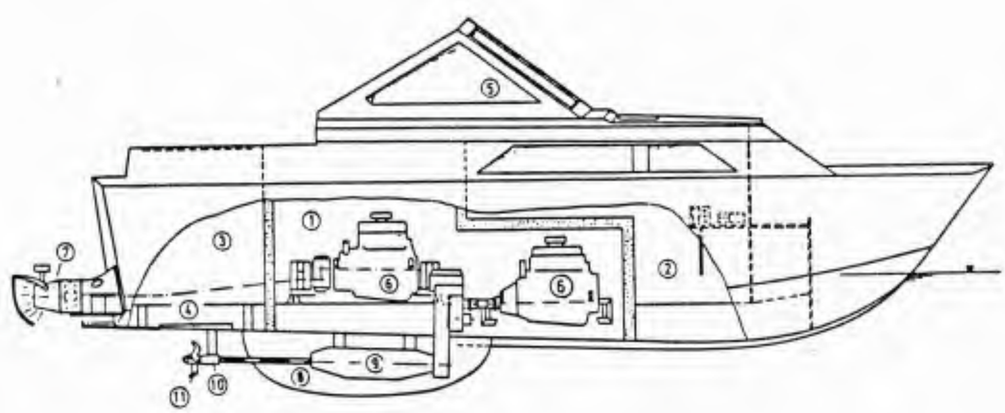
The boat is shown in Figure 5-14.

A propeller dynamometer (180 kW, 4000 rpm) is located within the displacement body on the hull bottom.

The viewing window can be seen directly above the propeller. This window is used for the high speed camera and for video recording. The inception of cavitation is determined through the viewing window using strobe lights for illumination.

The programs for which VITESSA is used are all concerned with cavitation and cavitation noise. The cavitating surfaces may be propellers or may be any one of a variety of foils.

Dr. Bartels is the principal investigator on this program.



(1) Engine room
(2) Instrumentation and Control room
(3) Observation room
(4) Glass - bottom
(5) Boat control
(6) Engines BPM Oceanic (195 kW, 66 U/s)
(7) Water jets Castoldi 06
(8) Displacement body
(9) Propellerdynamometer
(10) Shaft bearing
(11) Testpropeller

Figure 5-14. R/V VITESSA

Narrative Description (Cont'd):

The most significant problem in connection with VITESSA is that its use is restricted (by environmental concerns) to the months of January through May and September through November. All underway testing for each study must be completed during these months.

A firm plan has been generated which would lay out a marked area in the deep water (262 ft./80 m.) part of the Lake for use as a high speed cavitation noise measurement range. The range would be 3.1 mi./5 km. long and 197 ft./60 m. wide. Near the center of the range would be two buoys separated by 26-33 ft./ 8-10 m. as indicated in Figure 5-15. A hydrophone array of as yet undetermined number and type of elements will be suspended 16.4 ft./5 m. below the surface. VITESSA will, of course, pass between the buoys and over the array.

Acoustic signals will be telemetered to the shore laboratory (DEC PDP 11/34) for processing.

There will be a radar on VITESSA for such tests. In addition, a 3.3 ft./1-m. diameter floating buoy will be installed as an "artificial island" which will support an omnidirectional radar transponder for on-line determination of range from the hydrophone array and of vessel speed.

One final facility at Ammersee is a twin-hull catamaran type of vessel designed for noise experiments when moored (or lying to) on the Lake. (See Figure 5-16.)

The cruising speed of SILENTA is 5 kt./2.5 m/s. Other data are: length--36.7 ft./11.2 m.; beam--variable from 16.4-26.2 ft./5-8 m.; propulsion--two small (interchangeable) outboard engines.

The working space is a platform between the two hulls. SILENTA is provided with a hydrophone frame which allows the measurement hydrophones to be moved freely in X, Y, and Z directions. The vessel is equipped with a magnetic tape recorder and some noise analysis instrumentation.

SILENTA can handle the models and/or structural parts up to 13.1 ft./4 m. in length and up to 220 lb./100 kg. in weight.

SILENTA was used in the past for model noise tests, simulated engine noise, propeller noise, blade vibration noise, and measurements of structure-borne noise. It has, however, been largely replaced recently in these kinds of measurements by STRUCTURA, which is a larger, heavier platform of greater stability.

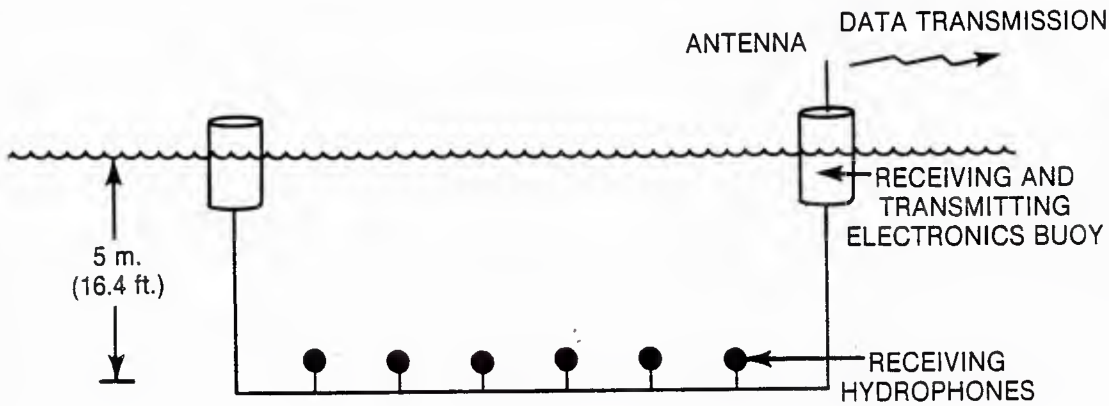


Figure 5-15. Proposed Cavitation Noise Measurement Array

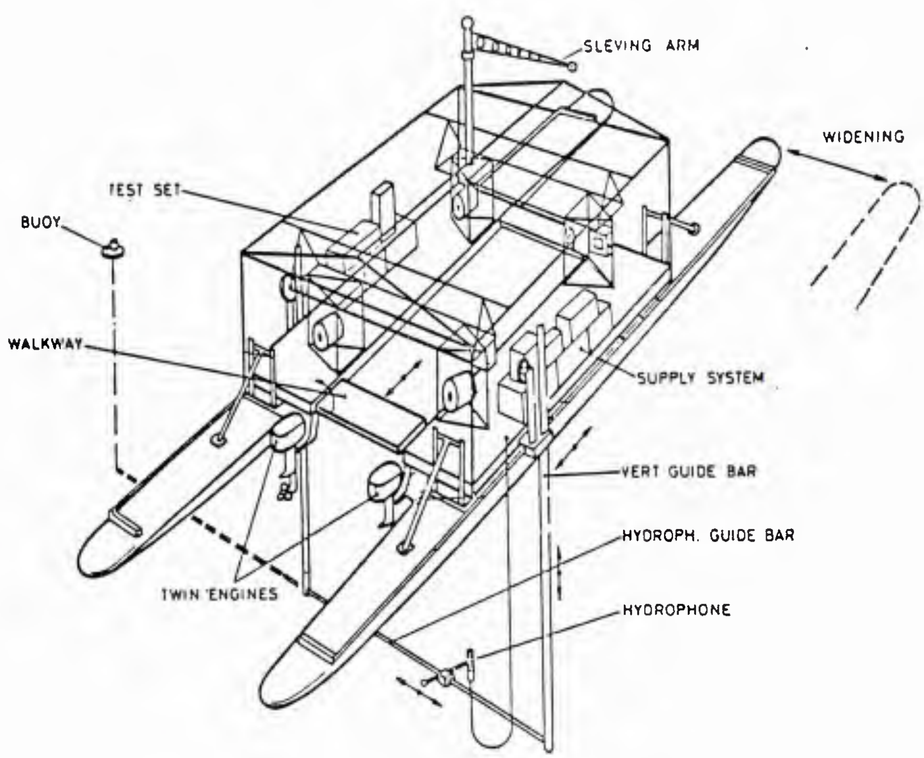


Figure 5-16. SILENTA

Date of this Summary
10 July 1985

Facility Name: Forschunganstalt der Bundeswehr für Wasserschall und Geophysik (FWG) (in English: Federal Armed Forces Underwater Sound and Geophysics Research Institute (GEFAFUSGRI))

Location: FWG offices and laboratories are on Klausdorfer Weg on the harbor waterfront in the northeast section of Kiel, Federal Republic of Germany. (Fig. 5-17). Kiel is on the Kieler Bucht which opens into the Ostsee. Kiel is easily accessible from Hamburg by rail, bus, or auto (Fig. 5-18).

Local Enviroment: The offices and laboratories of FWG are on the waterfront in the NE part of Kiel. There are active habor noises and some city traffic noise. Most acoustic work is performed elsewhere, however, so the proximity to the city is not significant.

Cognizant Organization: Business activities are supervised by Bundesamt für Wehrtechnik und Beschaffung (BWB) (in English: Federal Office for Military Technology and Procurement). Professional activities are supervised by the Bundesminister der Verteidigung (BMVg), (in English: Federal Ministry of Defense (FMOD)).

Facility Functional Name: FWG

Major User(s): FMOD, BWB, German Navy

Technical Areas Supported: Environmental acoustics, shallow water acoustic studies: transmission loss, reverberation, scattering, ambient noise, ELF application to remote control problems

Special Programs Supported: NATO MILOC Shallow Meadow, Resolute Support et al.

Unique Features: Military Research Vessel PLANET, Research Platform NORDSEE with acoustic active and passive arrays off the platform.

Significant Equipment Available: As noted above, the fully-equipped military research ship PLANET and the well-equipped laboratories on the Research Platform NORDSEE (used in connection with the acoustic range off that tower with both source and receiving arrays); weather satellite receiver and associated equipment; and a towed body (Schleppfisch) which measures pressure, temperature, conductivity, and sound speed

Facility Mailing Address: The Director
Forschungsanstalt der Bundeswehr
für Wasserschall und Geophysik
Klausdorfer Weg 2-24
D-2300 Kiel 14
Bundesrepublik Deutschland
(Federal Republic of Germany)

Local Contacts: Director FWG
Tel: Int. Oper. +49 431 7204-100

Figure 5-17. FWG Office Building in Kiel

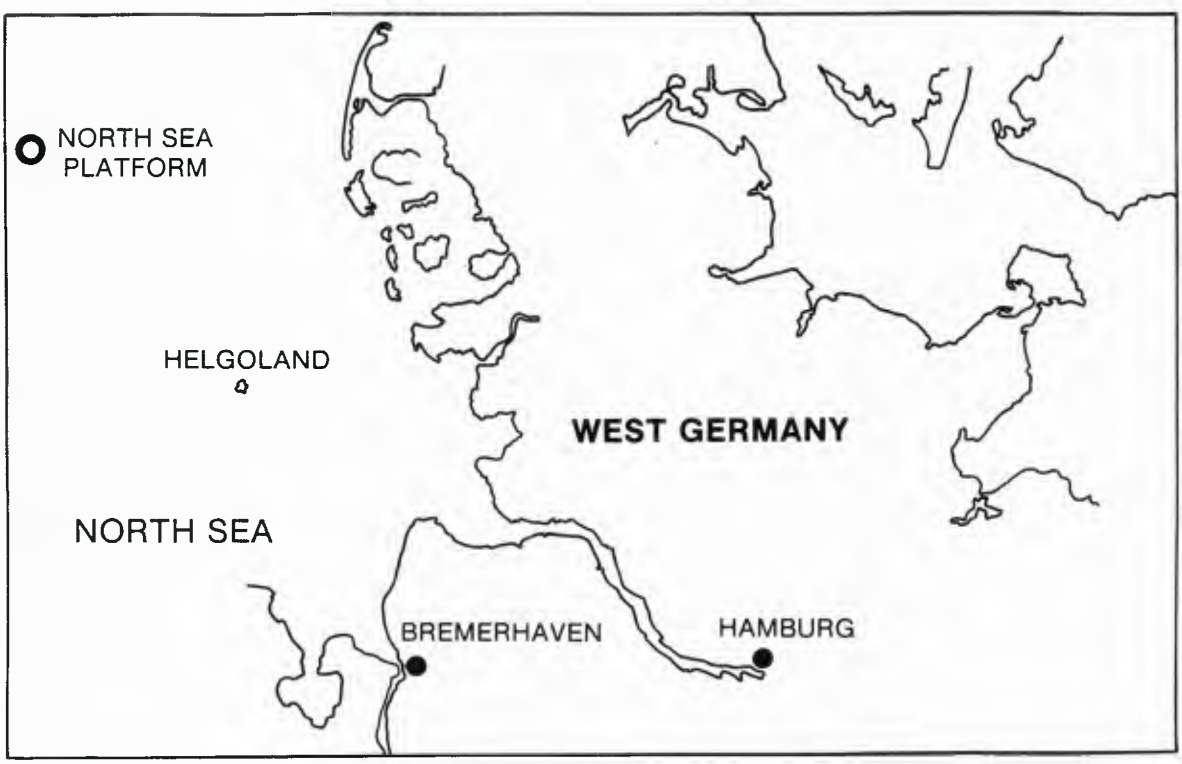


Figure 5-18. Location of North Sea Platform

Contact for Access/Scheduling:

To use the North Sea Platform, write to:
German Federal Ministry of Defense
- RüFo3 -
D-5300 Bonn
Bundesrepublik Deutschland

To use either MRV PLANET or the Research Platform NORDSEE independently of FWG, make schedule request to Federal Ministry of Defense, as above, with copy to Director of FWG at least two years in advance.

For information only concerning either the Acoustic Range off the Reseach Platform NORDSEE or MRV PLANET, write to FWG, as above.

Narrative Description: The Forschungsanstalt der Bundeswehr für Wasserschall- und Geophysik (FWG) was established in 1964. The current FWG staff numbers 140 persons. Of the 140, there are: 25 scientists, (Doctorates, Masters' degrees), 25 engineers (Bachelors' degrees), 25 technicians, 25 clerical and administrative, and 40 PLANET crew.

The operation of the Military Research Vessel PLANET is under the Supporting Activities Division and the operation of the acoustic source and receiving arrays of the North Sea Platform is under the ACRA-FPN Project Management Section.

The mission of FWG is to provide to the German Federal Ministry of Defense the expertise required in the areas of underwater acoustics, marine geophysical environment, and the marine electromagnetic environment for purposes of conducting applied research in those areas and for consulting and contract monitoring in the same areas.

In addition to the larger facilities like MRV PLANET and the Acoustic Range off the Research Platform NORDSEE, there are other available facilities such as:

- Towed Fish (Schleppfisch), similar to the Canadian Batfish
- Thermistor Cable
- Side Scan SONAR
- Towed Hydrophone Cable
- ACOUSTIC TANK 5 x 5 x 5 m^3 with absorbers and isolated against structural noise
- Self recording bodies for recording of borial and penetration processes
- 3-Channel-ELF-Noise-Recording-Equipment
- Computer facilities (VAX 8630)
- Weather Satellite Receiver (UKWTECHNIK)

Date of this Summary
11 July 1985

Facility Name: Wehrforschungsschiff (WFS) PLANET (in English: Military Research Vessel (MRV) PLANET) (Fig. 5-19)

Location: At FWG-pier in Naval Arsenal in Kiel, Federal Republic of Germany

Cognizant Organization: Forschungsanstalt der Bundeswehr für Wasserschall und Geophysik (FWG) (in English: German Federal Armed Forces Underwater Sound and Geophysics Research Institute (GEFAFUSGRI)).

Facility Functional Name: WFS "PLANET"

Major User(s): FWG Underwater Acoustics Branch, Geophysical Branch, Electromagnetic Branch. Surveys 16 weeks/year, Universities and Institutes with MOD contracts, German Naval Office

Technical Areas Supported: Oceanography, bathymetric studies, geophysical, studies, bottom studies, underwater acoustics, electromagnetic studies

Unique Features: Extremely quiet "silent ship" condition with a dedicated auxiliary diesel totally isolated from ship hull or other structures; one large and two small internal wells which extend from main deck through lower deck ("between decks") and bottom deck ("tank deck"); has underway fin stabilizers

Significant Equipment Available: Television camera on fantail with sonar monitor on bridge; three radars, 3.9 in./10 cm., 1.2 in./3 cm. (repeater in laboratory), and a 3 cm./400 km. range weather tracking radar for use with weather balloons; Decca navigation system; Transit Satellite navigation system (Magnavox), Loran C, Decca Plotter, bow thruster and active rudder; two hydraulically operated A-frames for towing; helicopter pad; BT winch and an oceanographic winch; Met-Equipment

Local Environment: Research vessel, home ported in Kiel, FRG

Future Plans for Facility: Expect to continue operations participating in several major international cooperative measurements. No major changes to the vessel indicated. Successor vessel is planned.

Facility Mailing Address: Director
Forschungsanstalt der Bundeswehr
für Wasserschall und Geophysik
Klausdorfer Weg 2-24
D-2300 Kiel 14
Bundesrepublik Deutschland
(Federal Republic of Germany)

Local Contacts: Tel: Int. Oper. +49 431 726 070 Ext. 7900

Contact for Access/Scheduling: For information, contact Director FWG as above. For use of PLANET, independent of FWG schedule, make written request to:

Federal Ministry of Defense
- Rüfo 3 -
D-5300 Bonn
Bundesrepublik Deutschland

Request must be made two years in advance, with a copy to FWG.

Narrative Description: The Wehrforschungsschiff (WFS) "PLANET," translates into English as the Military Research Vessel "PLANET." PLANET was commissioned in 1967 and made her first research cruise in 1968. PLANET normally carries a crew of 39 and one medical doctor and has facilities for carrying up to 15 scientists. (The ship is provided with a very well-equipped sick bay.) The principal data are given below:

Length overall:	264.4 ft./80.6 m.
Beam:	41.3 ft./12.6 m.
Draft:	12.8 ft./ 3.9 m.
Displacement:	1917 displacement tons
Propulsion:	Diesel electric, single screw
Max. speed:	13.4 knots
Cruising speed:	10-11 knots
Range at max. speed:	9400 nmi.

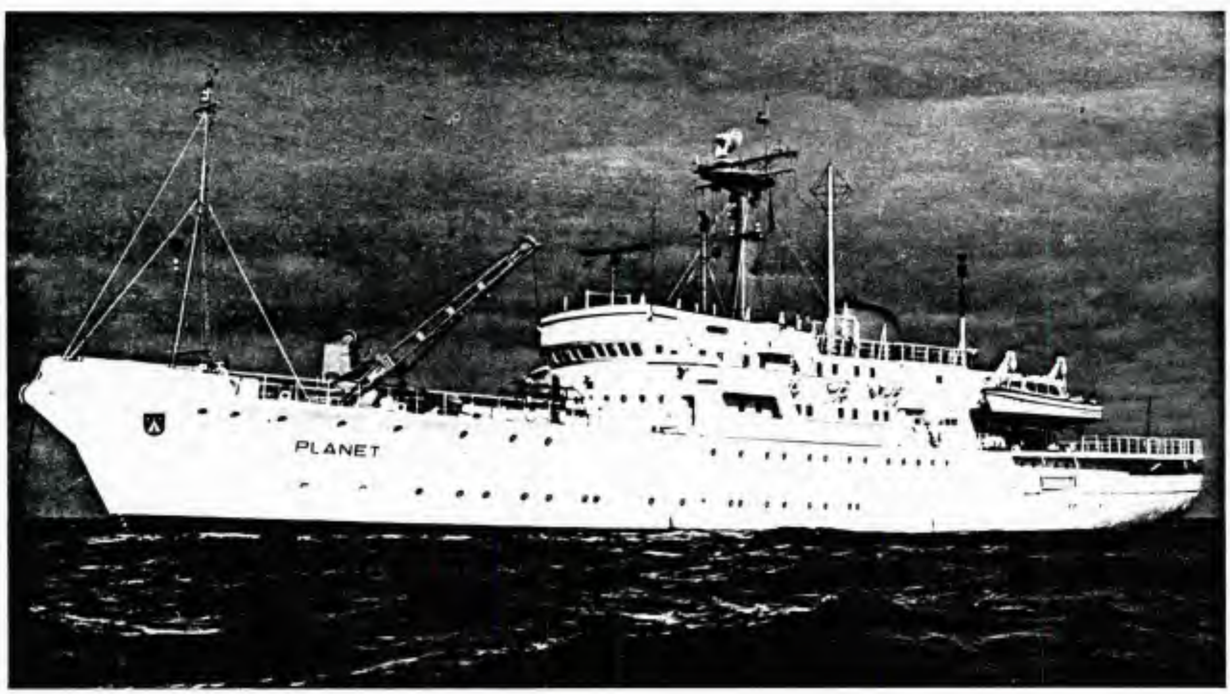


Figure 5-19. Wehrforschungsschiff PLANET

Narrative Description (Cont'd):

The ship has four diesel electric generators, two max. at a time, for propulsion, 560 kW at 275 Vdc each. Normally, two generators are used at a time working on the propulsion double motor and the third is working for the electrical users.

Max. three diesel electric generators are usual for housekeeping needs and for scientific work. In this case each generator provides 460 kW at 225 Vdc. There are voltage stabilizers in each laboratory space, and all NATO frequencies and voltages are available in each laboratory from a number of motor-generator conversion sets.

The power choices available for onboard scientific programs include:

3 Ø, 380 V, 50 Hz, 30 kVA
3 Ø, 220 V, 50 Hz, 20 kVA
3 Ø, 440 V, 60 Hz, 30 kVA
1 Ø, 115 V, 60 Hz, 10 kVA
3 Ø, 440 V, 400 Hz
1 Ø, 115 V, 400 Hz

For silent ship operation, there is a separate auxiliary diesel generator, extremely quiet, located on the port side of the main deck. This is an air-cooled unit, totally isolated from the sea, the hull, or other ship structures. It is adequate for providing power for the scientific laboratories, the gyro, the radars, the refrigerators, and the freezers for 12 hours continuous duty.

PLANET is a single screw vessel and, in addition to the normal propeller, is provided with both a bow thruster and an active rudder for added maneuverability and station-keeping capability. The main engines, the bow thruster and the active rudder are all controllable from the bridge and from the starboard wing as well.

A research cruise may be five or six weeks in duration. Customarily, the ship will put to sea and remain out for two to three weeks before putting into a fueling port. The ship and major facilities are always operated by the FWG staff from Kiel, while scientists from other laboratories and other (NATO) countries may also be onboard and would operate any special equipment for which they are responsible.

The principal ship user is FWG in Kiel. Other users include the universities or institutes with Ministry of Defense contracts, the German Naval Office and other NATO research groups.

A large part of the contractor work is concerned with bottom studies of one kind or another, geophysical work, bathymetric surveys, etc. The FWG towed body (Schleppfisch) is used in oceanographic surveys perhaps twice a year for a total of eight weeks measurement time.

PLANET is provided with a small helicopter pad and hangar. This allows PLANET to receive helicopters but not to initiate flights since no helicopter is carried onboard.

Narrative Description (Cont'd):

A set of three wells is available for access to the sea from within the ship. The main well measures approximately 6.5 x 6.5 ft./2 x 2 m. and the two small wells measure 19.6 x 31.5 in./50 x 80 cm. each. The wells extend from the main deck (working deck) down through the lower (between decks) deck and the tank deck (lowest deck) to an opening through the hull which can be opened or closed by locking plates operated from above. Monorail and traveling hoists are located over the wells for heavy handling. The well arrangement is indicated in Figure 5-20.

A second heavy-duty A-frame is installed on the fantail which swings outboard over the stern. This is also used for towing acoustic towed arrays, streamers, etc., or for lowering such items as thermistor chains. This stern A-frame is used in conjunction with the main winch which is a drum with 3936 ft./ 1200 m. of .55-in./14-mm. steel wire rope and one capstan on each side.

The scientific laboratories are spacious with ample relay rack space and ample storage space. The laboratories are well supplied with work benches, tables, and desk areas.

The wet laboratory is immediately aft of the acoustic/electronic laboratory and is equipped with metal sinks, wet tables, and lockers as well as a desk and work bench.,

The acoustic laboratory has the radar repeater, fathometer, search light sonar, power distribution controls, its own sink, and a refrigerator. In addition, along the aft bulkhead is located the HP 1000 computer with two 7970E digital tape recorders, a 2607A line printer, and a paper punch.

Quarters for scientists include 7 very roomy double rooms (stacked bunks) with heads and showers shared with other staterooms and one chief scientist room with private head and shower.

A conference room containing a conference table and 12 chairs is used only for conferences and is otherwise empty.

PLANET is very well equipped with handling gear. The large crane on the fore deck seen in Figure 5-20 is a 5.5-US ton/5,000-kg. crane, hydraulically operated. This crane can be used in moderate seas if necessary and is used for lowering such items as the large underwater camera assembly.

A 3.3 US-ton/3-metric ton A-frame is located on the starboard side outside a large sliding bulkhead hatch. The A-frame is hydraulically operated and is used for towing sound sources, Schleppfisch, or other oceanographic instrumentation, as well as for bottom sampling devices. It can swing 3.3 US tons/3 metric tons outboard to a distance of 6.5 ft./2 m. The A is 7 ft./2.1 m. wide at the base and 3.3 ft./1 m. wide at the top. When swung fully outboard and resting on its bracing fixture, it can support a weight of 18.7 US tons/15 metric tons.

A bathythermograph winch is also located on the starboard side along with another light duty oceanographic winch.

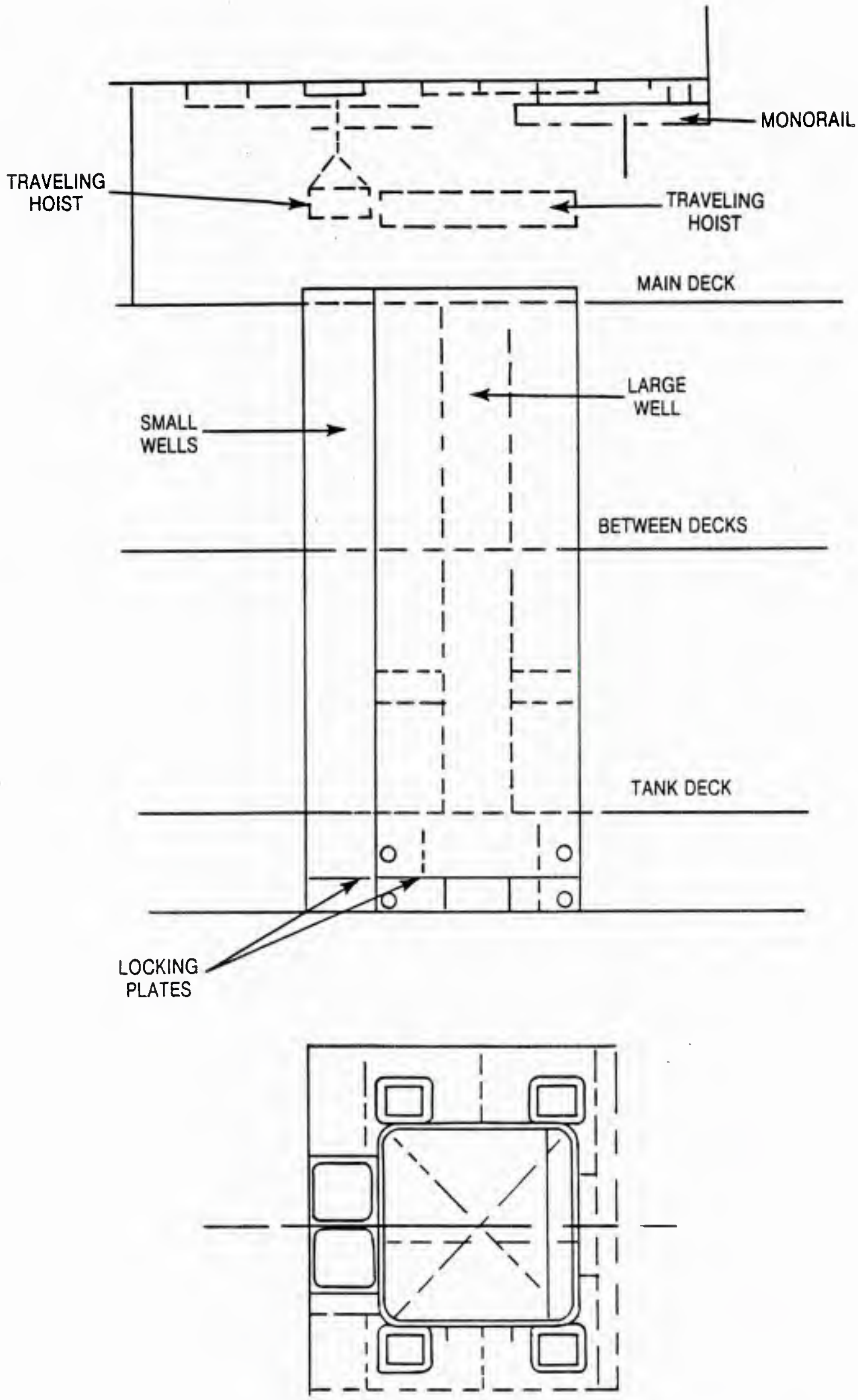


Figure 5-20. PLANET Well Arrangement

Narrative Description (Cont'd):

Anchoring facilities:

2 bow, 1 stern anchor
1 bow anchor useable for deep sea anchoring,
storage winch 8000 m, 16 mm Ø steel wire delivering a friction deep sea anchoring winch 15 to (working on the starboard A-frame)..

Date of this Summary
12 July 1985

Facility Name: Forschungsplattform Nordsee (FPN)

Location: In the North Sea, 40 nmi./74 km. from Helgoland bearing 320°T

Cognizant Organization: The Platform itself (FPN) is operated by the German Ministry of Research and Technology. FWG Kiel is a tenant with activities including acoustic source and receiving arrays in the water and termination on the Platform.

Facility Functional Name: Forschungsplattform NORDSEE, in English: Research Platform NORDSEE

Major User(s): 70% Ministry of Research and Technology, 30% Ministry of Defense

Technical Areas Supported: Underwater acoustics propagation, scattering, reverberation, and oceanographic, meteorological, and geophysical studies

Unique Features: Three high power sources attached to Platform covering the frequency band from 500 Hz to 10 kHz and variable in depth, elevation, azimuth; a long line near-bottom receiving array covering the frequency range from 10 Hz to 15 kHz

Significant Equipment Available: Helicopter pad (10 metric ton load capacity); transmitting and receiving arrays; excellent workshops--electrical, machine, welding, electronic; radio communications room; radars--60 nmi./109 km. and 36 nmi./68.4 km.; 12-ton telescoping crane; divers' room; computers: Commodore 8032 with printer and dual floppy disc drive, Commodore 3032; four 5 kW power amplifiers; receiving amplifiers; spectrum analyzer; Ampex 1-inch magnetic tape recorder

Local Environment: In the North Sea, Platform stands in 98 ft./30 m. of water on a sand bottom. Platform is about 40 nmi./74 km. from Helgoland on a bearing of 320°T. Subject to frequent high winds and seas.

Future Plans for Facility: Continue measurement program

Facility Mailing Address: RF Reedereigemeinschaft
Forschungsschiffahrt GmbH
August-Bebel-Allee 1

D 2800 Bremen 41
Bundesrepublik Deutschland
(Federal Republic of Germany)
Betreff: Forschungsplattform NORDSEE

Local Contacts: For information regarding the acoustic array installations or operations, contact: Director Forschungsanstalt der Bundeswehr für Wasserschall und Geophysik (FWG), Klausdorfer Weg 2-24, D-2300 Kiel 14, Federal Republic of Germany, Telephone Int. Oper. + 49 431 726 070 ext. 7900.

Contact for Access/Scheduling:

German Federal Ministry of Defense
- RüFo 3 -
D-5300 Bonn
Federal Republik of Germany

Request should be made at least two years in advance, with a copy to FWG.

Narrative Description: A sketch of the North Sea Platform (Forschungsplattform Nordsee) is given in Figure 5-21.

The Platform is located at 54° 42' 5.8" N, 7° 10' 9.2" E, which is a point 40 nmi./74 km. from Helgoland on a bearing of 320°T. (See Figure 5-27.)

The Platform was built in 1974-75 by IMS (Ingenieurgemeinschaft Meerestechnik und Seebau, GmbH) of Hamburg, Germany.

The Platform has a permanent crew of 9 people including: 1 manager, 1 electronic engineer, 1 electrician, 1 machinist, 1 diesel mechanic, 2 watchstanders (radio and/or visual in tower, 6 hours on/6 hours off, 24 hours per day), 1 cook, and 1 steward.

An additional 14 people (scientists, etc.) can be accommodated comfortably, and the absolute maximum number of people who can be berthed is 28.

There are two complete crews and the permanent staff is changed every two weeks.

The Platform is operated at an annual cost of 4.5 million DM/year (approximately $2.2 M/year), including maintenance, repairs, and improvements.

Personnel access to the Platform is normally by helicopter. Currently service is provided as required by Wasserthal GmbH Helicopter Service (up to 4 persons), located at the airport in Hamburg. (The cost for a round trip from Hamburg to Bremerhaven to Platform and return is about 5000 DM or approximately $2500.) For 5 to 9 persons service is provided by Wiking Helicopter Service from Mariensiel/Wilhelmshaven (price about 9000 DM).

The Platform is supplied by ship at intervals on the order of once every ten days to two weeks. In the event that personnel must be transported by ship, then the crane on the top deck is used for the personnel transfer as well as for the transfer of supplies.

FWG from Kiel makes greater use of the Platform than does any other single organization. The FWG underwater acoustic program is organized about the source and receiving arrays installed by FWG at the Platform.

The acoustic program at the Platform examines shallow water propagation in general with emphasis on underwater acoustic reverberation and scattering. A major advantage of the fixed platform is the capability of repeating measurements over a long term, demonstrating time dependence and dependence of acoustic results on changing oceanographic and weather conditions.

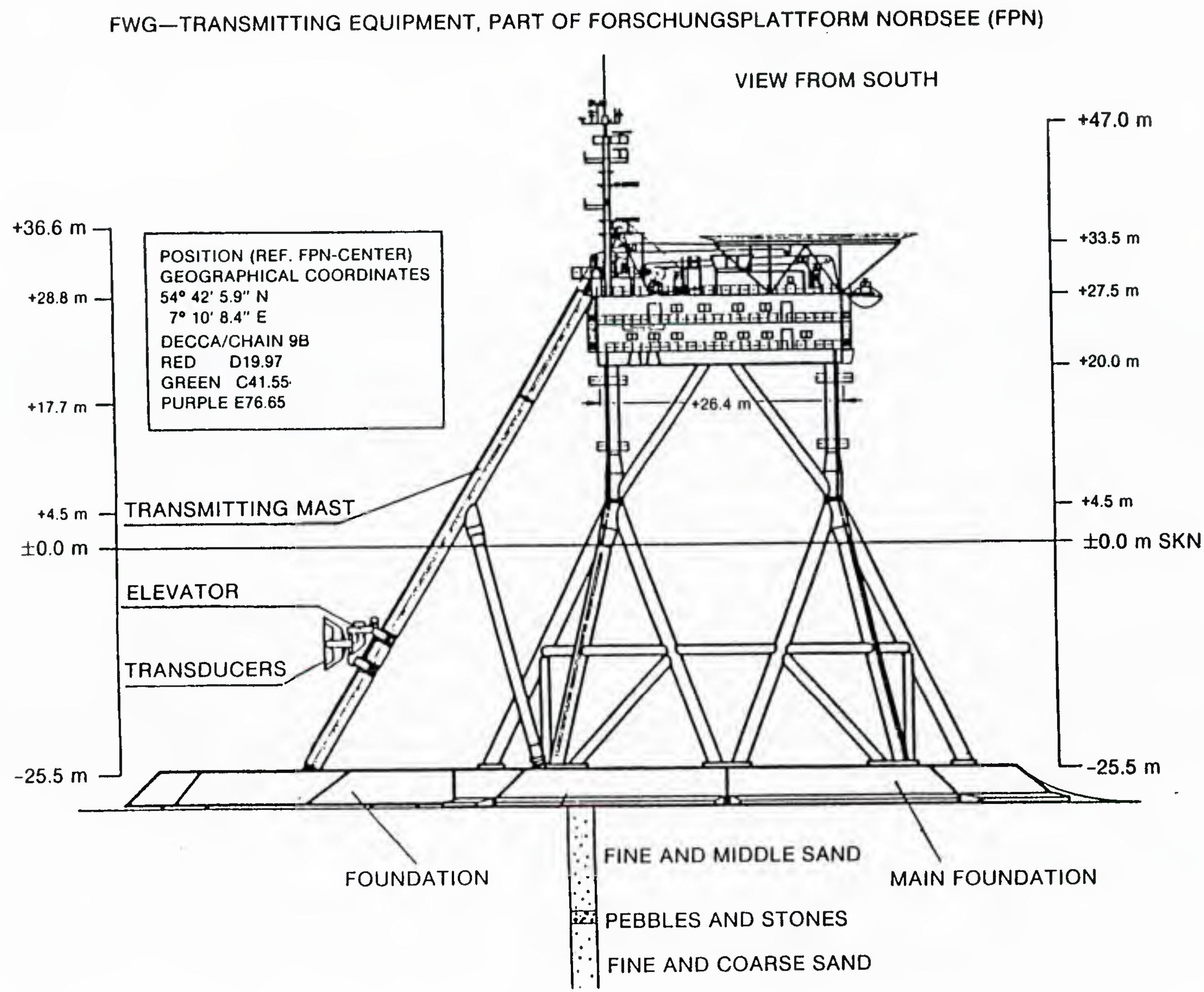


Figure 5-21. North Sea Platform

Narrative Description (Cont'd):

Other programs using the FPN monitor meteorological and oceanographic factors more or less continuously for the Ministry of Research and Technology. The Platform is used to record data on chemical pollution in shellfish, plankton counts, water currents, sediment transport, wind speed and direction, sea state, salinity, atmospheric opacity, rainfall, humidity, air temperature, water temperature, and chemical content of the sea water.

Weather data are sent to Deutsches Hydrographisches Institut (DHI) in Hamburg.

The FPN, shown in Figure 5-21, has four decks. The topmost deck, called the Haupt-Deck (or Main Deck), outlined in Figure 5-22, supports the helicopter pad and two large (5.5 US ton/5 metric ton) hydraulic cranes. The areas accessed by these two cranes are indicated by the two circles in Figure 5-22. A third telescoping crane can handle 1.8 to 12 metric tons, with a reach from 26-5 m. and is a diesel-electric-hydraulic unit which can be operated even if the primary power fails.

The combination instrumentation mast, watch tower, and radio antenna is also located on this deck as is a double-drum (5.5 US ton/5 metric ton) winch used for lowering instrumentation into the sea through a large central shaft which runs through all four decks. A heavy duty A-frame capable of handling 8.8 US tons/8 metric tons is used in conjunction with the winch to lower the instrumentation into the sea.

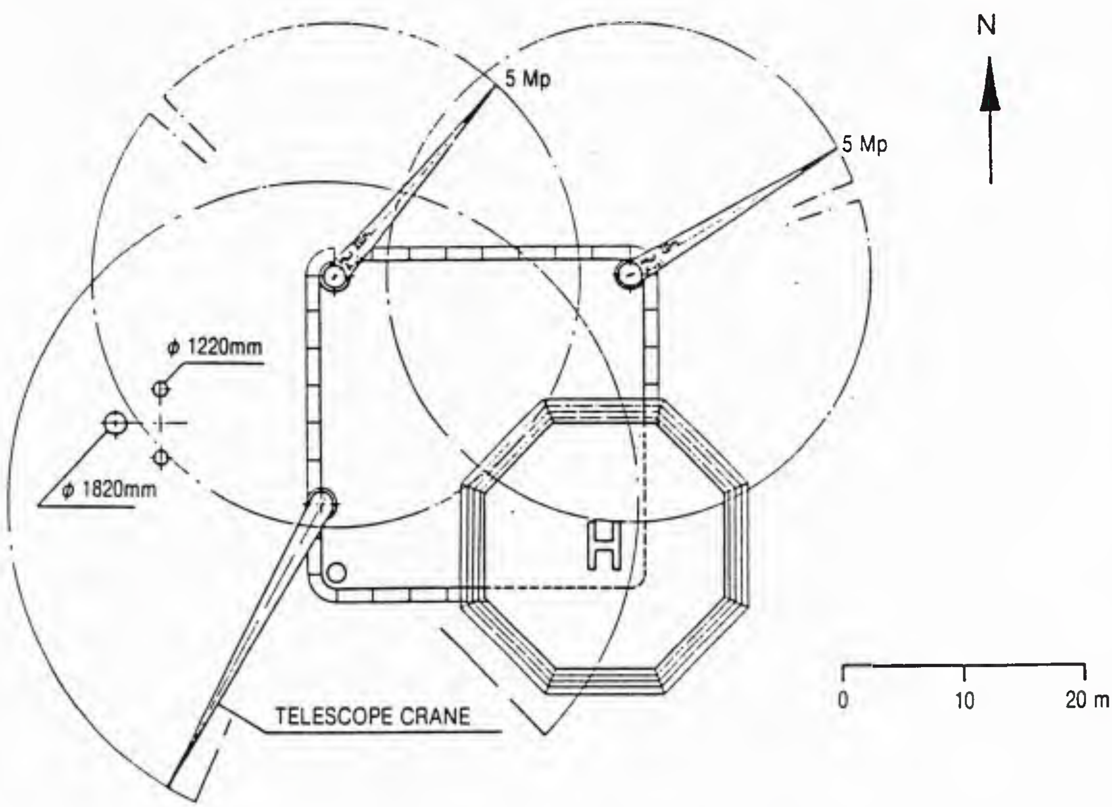


Figure 5-22. Cranes on the FPN

Narrative Description (Cont'd):

It should also be noted that since the diesel-electric-hydraulic telescoping crane in the southwest corner operates off its own generator, it can handle the lifeboat in the event that all other power is lost. There is also on this deck the Deck Engine Room, a neutralizer tank for wet lab chemicals, a saltwater fire fighting system, and foam booster pumps for the helicopter pad. There are two air compressors located on this deck; one for work air and one for divers' air. There is also an ultraviolet bacterial system and an oil filtration and separation system. The 28-man emergency escape capsule is located off the north side of the helipad and the 27 passenger lifeboat (which is handled by the telescoping crane) is located on the topmost deck, where also is located the working boat.

The deck immediately below the topmost deck is called the Oberdeck (upper deck) and houses the kitchen, mess room, stove rooms, conference room, TV room, laundry, workshops (electrical shop, machine shop, and welding and battery rooms), engine room, engine control room, photography laboratory, and a semi-portable one-man (will be replaced by a two-man chamber in 1987) decompression chamber. This deck also includes a platform measurement room to monitor and record the tower motion: twist, lean, and stretch.

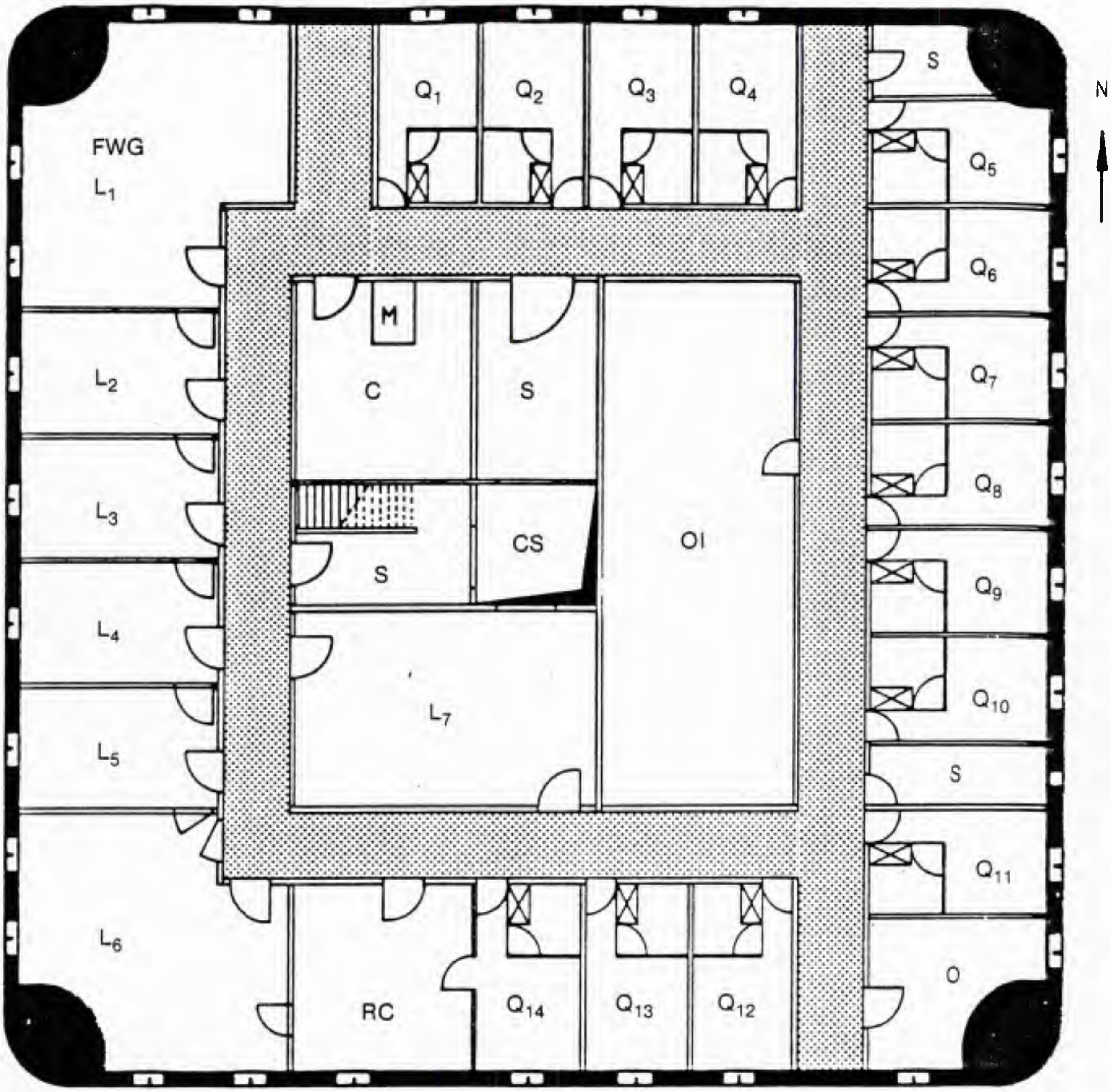
Two decks below the topmost deck is the Living Room Deck, called the Unterdeck (lower deck), which contains all 14 of the bunkrooms (7 for crew and 7 for scientists). The bunkrooms normally are used singly but can sleep two if necessary. Each room has a toilet and shower, desk, table, and radio. The FWG Underwater Acoustics Laboratory is located on this deck as is an oceanographic wet lab and an electronic data processing room. There are a total of 8 laboratories, including four smaller general purpose laboratories (161.4 $ft.^2$/15 $m.^2$), one larger room (269 $ft.^2$/25 $m.^2$), the wet lab and the FWG acoustic laboratory (376.6 $ft.^2$/35 $m.^2$). (See Figure 5-23.)

The radio room is on this deck but is now used primarily as a Telefax and copy room. The radio in the tower (where the watch is maintained) is used in preference since it is much more convenient to monitor and to use in conjunction with incoming ships and helicopters where the operator has visual contact as well. A "Heating Room" on this deck contains the hot water heating system, the comfort heating system, air conditioners, compressors, and blowers, as well as the fresh water evaporators.

Access to the Tank-Deck is from the Heating Room on the Unterdeck. The Tank-Deck is only half-normal room height and contains the Platform holding tanks and the storage tanks for fuel, seawater, and fresh water.

The outside catwalks go all the way around the Platform and there are two catwalks directly under the tank room, each of which runs from side to side across the Platform (intersecting at the center) for tower inspection purposes.

In the Engine Room, there are four 170 kVA generators and one 75 kVA emergency generator. (There is another 60 kVA emergency generator on the topmost deck to provide emergency power for communications, lights, and firefighting equipment.)



CS	:	CENTRAL SHAFT
C	:	EPP-ROOM
M	:	DATA DISTRIBUTION NET
O	:	FPN OFFICE
OI	:	OPERATIONAL INSTALLATIONS
$L_1 \ldots L_6$	:	LABORATORIES
L_7	:	WET LABORATORY
$Q_1 \ldots Q_7$	:	SCIENTIST'S LIVING QUARTERS
$Q_8 \ldots Q_{16}$	:	CREW'S LIVING QUARTERS
RC	:	RADIO COMMUNICATION ROOM (INCL. COPY MACHINE)
S	:	STORE

Figure 5-23. Research Platform North Sea Floor Plan, Lower Deck

Narrative Description (Cont'd):

The power available in some laboratories includes:

Several	220 V, 50 Hz wall sockets (10 A fuse)	
	380 V, 50 Hz	
	220 V, 50 Hz	normally 10 A fuses; some special sockets with 36 A fuses
	380 V, 50 Hz	
	220 V, 50 Hz	
35 kVA	440 V, 60 Hz	
	254 V, 60 Hz	
5 kVA	115 V, 60 Hz	

Two voltage stabilizers which provide 380 V, 3 Ø, 50 Hz max. 2 x 30 kVA in FWG-laboratory, and 24 VDC.

FWG has designed, installed and continues to maintain an acoustic source system at the Platform and a receiving array 5.6 nmi./10.4 km. distant from the Platform.

The receiving array is comprised of 30/26 receiving hydrophones in a straight line 656 ft./200 m. long and 6 hydrophones in a vertical line. The hydrophones are supported off the bottom on individual tripods 3.28 ft./1 m. high. (The hydrophones are spherical ceramic elements built by a Norwegian firm (ITC compatible).) The preamplifiers used in conjunction with these hydrophones were designed and built at FWG and are integrated with the hydrophone mast. Both received signal and (DC) power to the receiving array are carried in a single double-armored steel cable between the array and the Platform.

The receiving array has been destroyed and/or moved on occasion by fishermen. Divers must be employed to replace the array accurately. The array elements are checked for position acoustically and repositioned in the same manner when necessary. This acoustic positioning is accomplished with the use of four transmitters fixed on the bottom, one on each side of the array. See Figure 5-24.

The receiving array with its electronics is designed to record data across the frequency band from 10 Hz to 15 kHz.

FWG has also designed and installed a source array to be used in conjunction with the foregoing receiving array.

The transmitting array (also identified as the "Schallsender") consists of three units, and is patterned after the AFAR array off Santa Maria in the Azores. Each of the three active elements is backed by a parabolic reflector constructed of "squashed tubing" as proposed by William Toulis. (See Figure 5-25.)

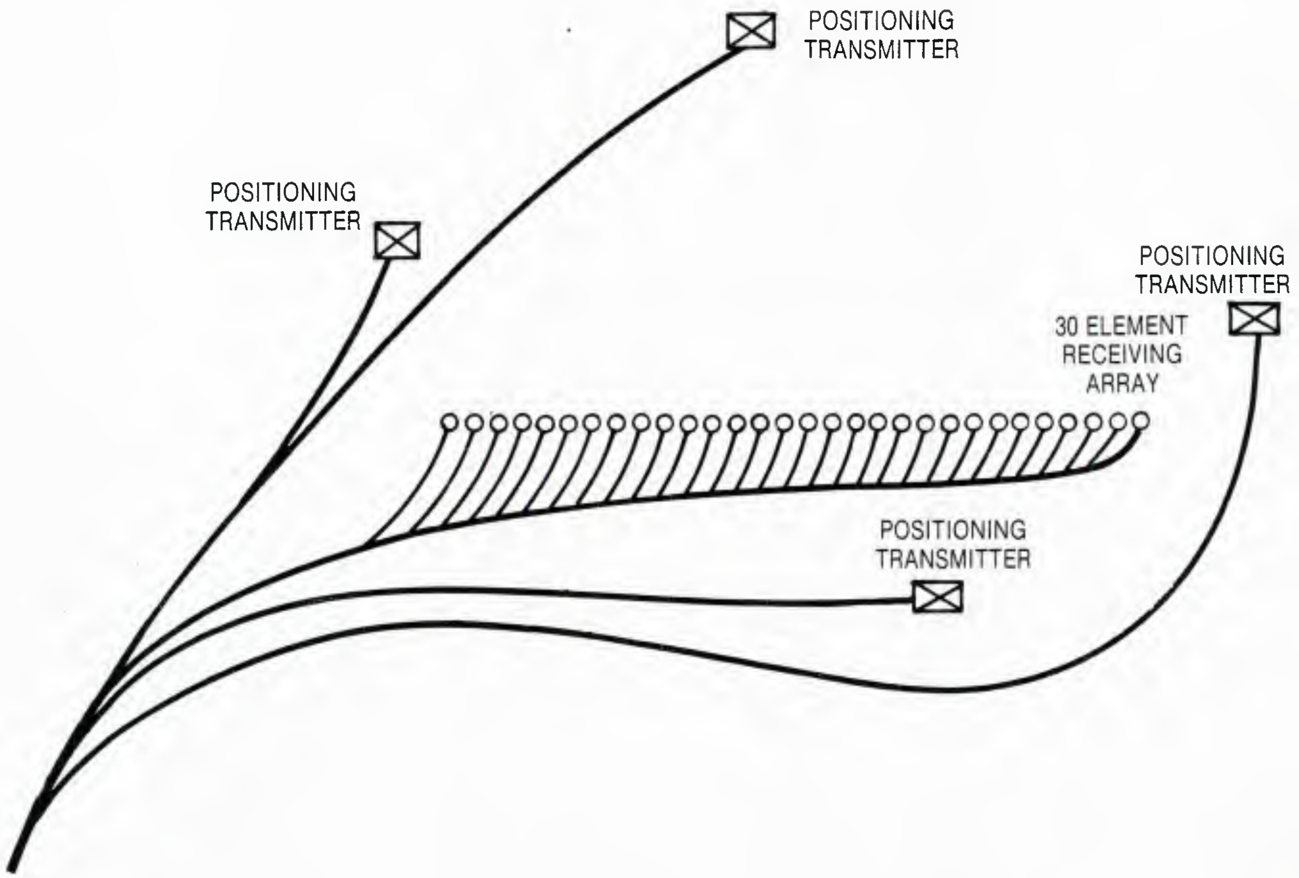


Figure 5-24. FWG North Sea Receiving Array

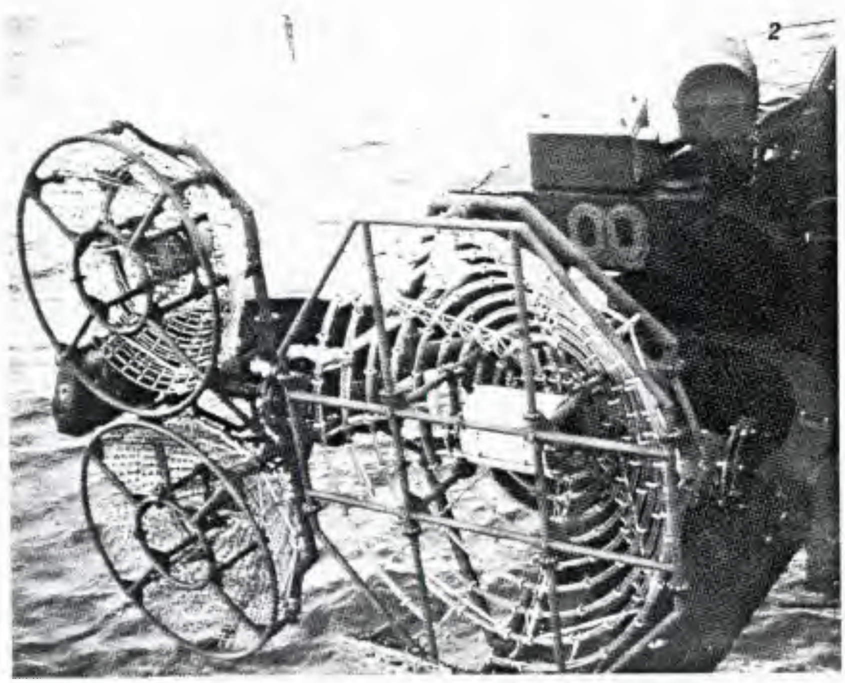


Figure 5-25. FWG North Sea Transmitting Array

Narrative Description (Cont'd):

The low frequency element in the large reflector on the right is a ceramic cylinder (consisting of stacked ceramic rings) built by Rockwell International in the U.S. The nominal frequency band for this acoustic transmitting antenna extends from 500 to 1500 Hz.

The two higher frequency active elements in the mid-frequency antenna (top) and the high frequency antenna (bottom) are flex-tensional sources with 20 to 40 ceramic rods in each unit and were built by ITC, also in the U.S. The nominal frequency ranges of these units are 1.5-4 kHz and 4-10 kHz, respectively.

All three parabolic reflectors in this Nordsee Transduction System (NTS) were constructed by Rockwell International.

The low frequency antenna of the source array can be driven continuously to an output level of +200 dB//1 µPa and can be pulsed at levels of +206 dB//1 µPa. The two higher frequency antennas can be driven continuously or pulsed to source levels of +220 dB//1 µPa.

The three transmitting antennas can also be used as receivers, and are provided with the necessary gating circuits and transmit/receive switching circuits for conducting monostatic reverberation measurements.

The entire source array can slide up and down the transmitting mast, identified as the "Sendemast" in Figure 5-21, to vary depth.

The source array rides on a mechanical arrangement known as the carriage (Farkorb) which can be seen at the top of the transmitter mast in Figure 5-26.

The array can not only be varied in depth from FPN-foundation to 5 m. below the surface, but can vary transmitting elevation angle from +30° to -30° and can vary transmitting azimuthal angle from +55° to -55° (from 230° to 340°).

At the very top of the transmitting mast, as in Figure 5-26, the array can be tilted to gain access for repairs or to provide maintenance.

The FWG acoustic laboratory is provided with the same power choices available in all the laboratory spaces, that is:

220/380 V, 50 Hz, stabilized and unstabilized
220/380 V, 400 Hz

254/440 V, 60 Hz
115 V, 60 Hz
24 VDC

Each laboratory space, including the FWG acoustic laboratory, is also provided with a fourteen-signal cable patch box. All laboratories are interconnected through a common central patch room through coaxial cabling. All shields are connected to a common ground in the EDV room.

Narrative Description (Cont'd):

All of the FWG instrumentation for control and monitoring of the source array, for signal transmissions, and for the measurement, recording, and processing of received signals is located in the FWG acoustic laboratory.

Included are:

Carriage Monitor Panel -- Depth
-- Azimuthal Angle
-- Vertical Tilt Angle

Four 5 kVA Audio Amplifiers (Delta Electronics Control Corp., Irvine, CA, Model 61108) (Remarks: Never worked satisfactorily; therefore will have to be replaced by new amplifiers)

Power Amplifier Control Panel

Signal Panel; Continuous, Pulsed, with Gating and T/R if required

In addition, there are also included:

Ampex Model PR2230-1, 1-inch Magnetic Tape Recorder
Kennedy Model 9218, Recorder and Format Control Unit
7 Ithaco Amplifiers, Model 481 Autogain
HP Spectrum Analyzer, Model 3582A
HP Voltmeter, Model 3437A
HP Scanner, Model 3495A

A radar monitor is also available in the acoustic laboratory. Other monitoring devices are:

HP Data Recorder (Printer) for Date, Wind Speed, Wind Direction
Two FS (Siemens) Punched Paper Tape/Printers

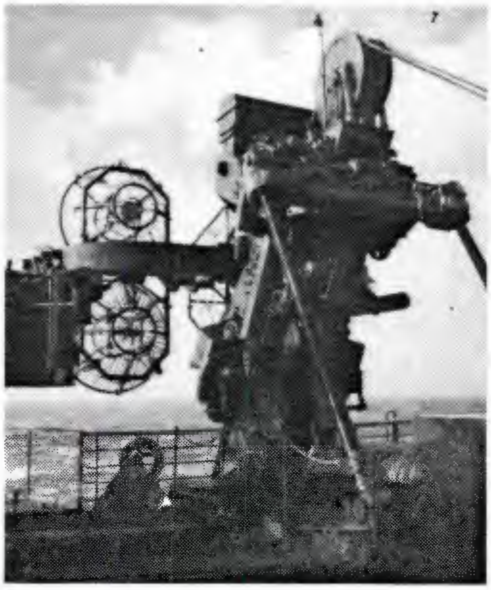


Figure 5-26. FWG North Sea Transmitting Array on Carriage

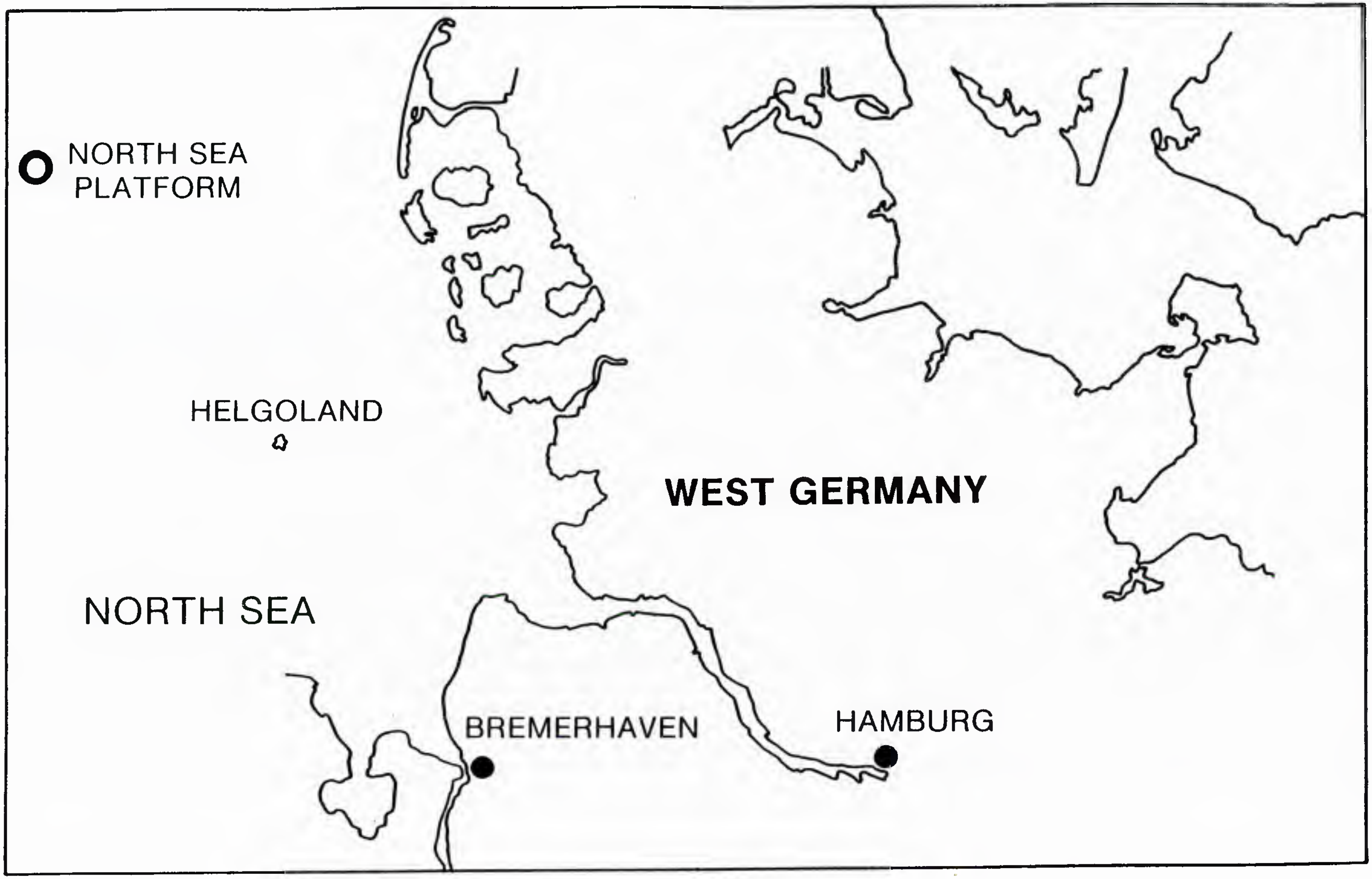


Figure 5-27. Location of North Sea Platform

Date of this Summary
6 September 1985

Facility Name: Sarzana Lake Facility

Location: Accessible by automobile; approximately 10 mi./16 km. east southeast of La Spezia on the east coast of Italy, southeast of the town of Sarzana, 492 ft./150 m. off the Viale Sarzana Marinella

Cognizant Organization: MARIPERMAN, Italian Navy

Facility Functional Name: Sarzana Lake Acoustic Measurement Facility

Major User(s): Italian Navy, Navy contractors (USEA, Motofides, etc.), SACLANTCEN, other NATO Navies

Technical Areas Supported: Transducers (hydrophones and projectors) and transducer array development

Unique Features: Convenient to ships in La Spezia, to SACLANTCEN (in La Spezia) and to USEA (in Lerici). Very quiet test site, stable platform, and no interference from small boats.

Significant Equipment Available: Motor driven rotating shaft tied to Bruel and Kjaer Type 2307 Recorder used in both linear and polar modes of operation; Revac 250 watt power amplifier and matching transformer; sine random generator, conditioning amplifier, gating system; band pass filters, preamplifiers, amplifiers, and dual channel oscilloscope with time base delay generator

Local Environment: Very quiet lake, soft clay bottom, 39 ft./12 m. deep. Lake is approximately 525 ft. wide x 1246 ft. long/160 m. wide x 380 m. long or approximately 654,520 $ft.^2$/60,800 $m.^2$

Future Plans for Facility: None specified.

Facility Mailing Address: Col. E. Diamanti
MARIPERMAN, Italian Navy
Viale San Bartolomeo 400
19026 San Bartolomeo
La Spezia
Italy

Local Contacts: Col. E. Diamanti, MARIPERMAN, La Spezia
Dr. Garozzo Benedetto, MARIPERMAN, La Spezia
Tel.: Int. Oper. + 39 187 560 940

Barge telephone is: Int. Oper. + 39 187 621 840 but Barge is not always manned.

Contact for Access/Scheduling: Col. E. Diamanti, MARIPERMAN, as above

Narrative Description: The Sarzana Lake Acoustic Measurement Facility is owned and operated by the Italian Navy and is under the cognizance of Col. E. Diamanti, who is located in the MARIPERMAN buildings on the Italian Navy Base at San

Narrative Description (Cont'd):

Bartolomeo in La Spezia. (MARIPERMAN is an acronym signifying the Italian Navy's "Permanent Commission for Experiments on War Material.")

Sarzana Lake is approximately 10 mi./16 km. east southeast of the center of La Spezia, and is southeast of the town of Sarzana. It is accessed by automobile, and lies just 165 yd./150 m. off a secondary road identified as the Viale Sarzana Marinella.

The lake is an abandoned clay digging (quarry) which material was used for making building blocks. The digging is now flooded and the result is a lake about 39 ft./12 m. deep with a soft clay bottom, approximately 525 ft. wide x 1246 ft. long/160 m. wide x 380 m. long.

Roughly one quarter of the lake shore is privately owned and three quarters are government owned. Clearance from the Italian Navy is required for access to the measurement facility.

If classified material is present, the facility is guarded 24 hours/day; otherwise, the site is not guarded at all, but does have a locked access gate.

When the facility is in use, two technicians are always present--one electronic technician and one general technician.

The area around the lake is thinly settled and there are no power boats on the lake so that it is a very quiet body of water.

The measurement platform on the lake was originally a harbor utility boat which was converted to the present Calibration Barge and is identified by the number GQ 90.

Transducers, electronic equipment, or other material to be used on the Barge can be driven by truck directly to the lake shore. A small crane on the shore with a lifting capability in excess of 700 lb./320 kg. will transfer such material to two small transport floats (each of which measures 6 x 9.8 ft./2.5 x 3 m. and each of which has a carrying capability of 1930 lb./650 kg.).

A davit on the Barge is equipped with a hoist having a 1100-lb./500-kg. limit which will transfer the material from the float(s) to the Barge.

The Barge has an overall length of 72 ft./22 m. and a beam of 19.7 ft./6 m., and is fitted with a large deck-house which encloses an internal well, an office, and a laboratory space. (See Figure 6-1.)

The Barge has a hydrophone/transducer handling system installed along one side of the platform. (The interior well is used only for reciprocity measurements of smaller units.) The handling system consists of a monorail along the top edge of the deckhouse, two traveling hoists, and an extendable shaft which is motorized for rotation. See Figure 6-2.

The Barge draft is 4.26 ft./1.3 m. and the shaft is nominally 16 ft./5 m. long, but is extendable to 40 ft./12 m. The top of the shaft is 6.5 ft./2 m. above

Narrative Description (Cont'd):

the surface of the water and supports the motor for rotating the shaft to generate directivity patterns. (The motor is electrically synchronized with a polar plotter in the laboratory within the Barge.)

Immediately inside the deckhouse on the main deck level is a small office 10 x 10 ft./3 x 3 m., equipped with a desk, telephone, etc.

Below the main deck is the air conditioned laboratory and shop space for mechanical and electronic repairs and maintenance with benches, vice, etc., as well as storage for equipment and supplies.

A well, open to the lake, is located within the laboratory space. The well measures 3.3 x 5.9 ft./1 x 1.8 m. and is used almost entirely for reciprocity calibrations of the standards. The geometry for these calibrations is established by a triangular wooden frame, measuring 3.3 ft./1 m. on a side, which is fixed to the top of the well and the cables of the hydrophones/transducers involved are secured to the corners of the triangular fixture.

The instrumentation in the laboratory is located in three relay racks as shown in Figure 6-3.

Three cables are brought out to the Barge from shore:

1 Telephone Cable (Tel.: Int. Oper. + 39 187 621 840)
1 Power Cable in Use (380 volts, 3 Ø, 50 Hz, 10 kW)
1 Spare Power Cable

A step-down transformer on the Barge makes the following power also available:

220 V, 50 Hz, 1 Ø
110 V, 50 Hz, 1 Ø

Questions concerning instrumentation or technical operation of equipment on the Barge should be addressed to Dr. Garozzo Benedetto at MARIPERMAN as indicated earlier.

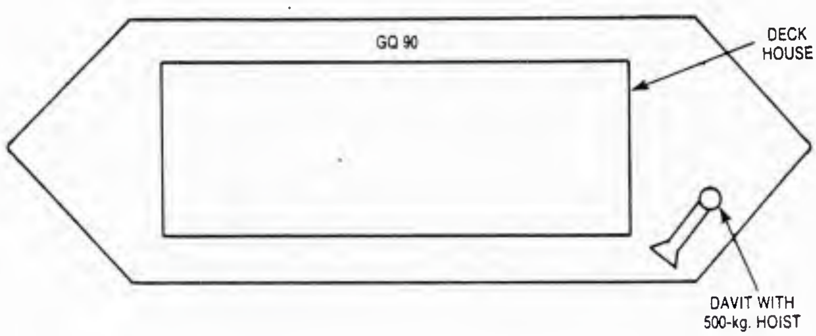


Figure 6-1. Sarzana Lake Measurement Facility

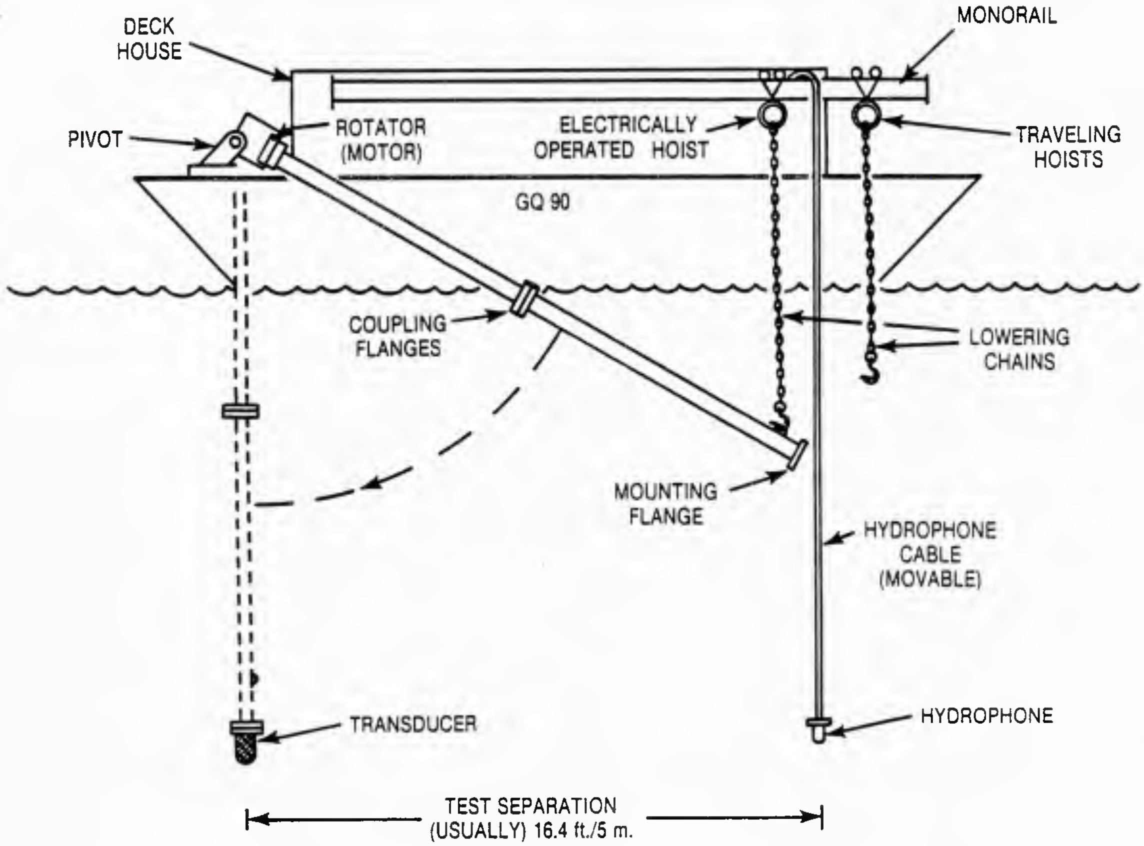


Figure 6-2. Sarzana Lake Barge Transducer Handling System

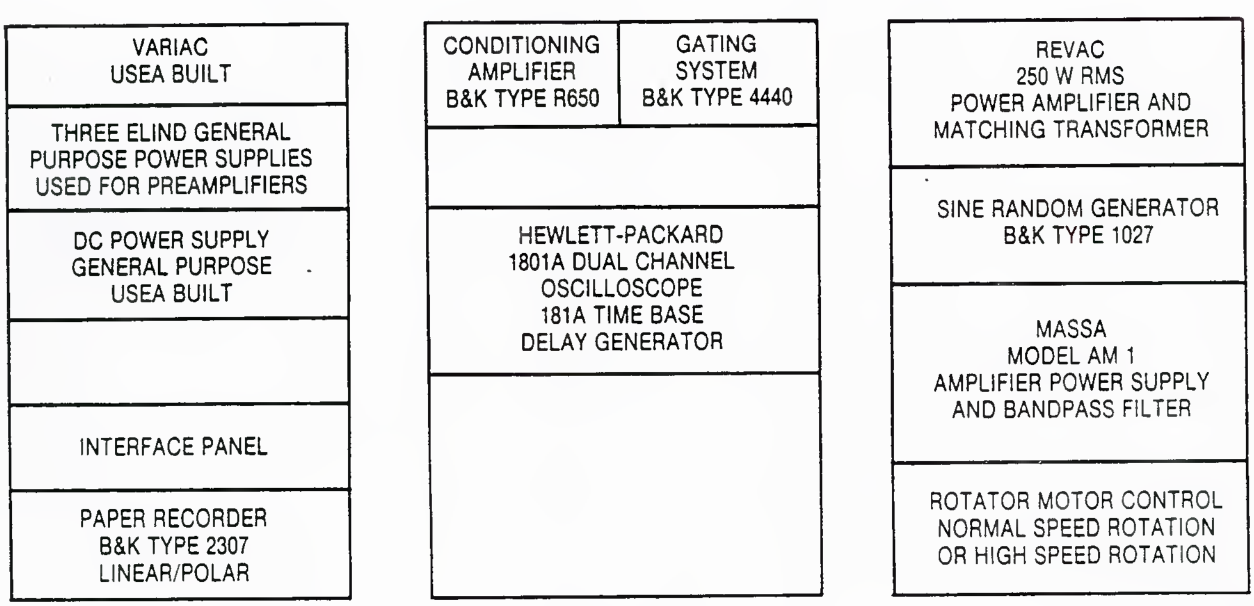


Figure 6-3. Sarzana Lake Laboratory Instrumentation

Date of this Summary
10 September 1985

Facility Name: Ufficio Studio Elettro Acoustica (USEA) SpA

Location: At via Matteotti 63, on a hill on the northeast side of Lerici. Lerici is approximately 5 mi./8 km. southeast of SACLANTCEN in La Spezia on the west coast of Italy.

Cognizant Organization: USEA SpA is owned jointly by ELSAG and Whitehead-Motofides.

Facility Functional Name: USEA SpA Transducer Facilities

Major User(s): USEA SpA., Italian Navy, ELSAG, Whitehead-Motofides

Technical Areas Supported: Transducer Development, Sonar Design and Development, Underwater Communications, Underwater Telemetry

Unique Features: Large redwood calibration tank with carriages controllable locally or by radio from console; pitch and roll capability for unit under test; and heavy-duty (2-US ton/1.8-British ton) rotator and shaft

Significant Equipment Available: Above-mentioned redwood calibration tank, 29.5 ft./9 m. in diameter and 23 ft./7 m. deep. Handling capability is 2 ton, including S.A. Rotator. Main computer is VAX 750. Two PDP 11/23 computers, one HP 9836 and two HP 1000 series computers with floating point array processor. Both digital control/recording system for tank and in parallel an analog control/recording system. Two power amplifiers, 300 W and 400 W. VIP 100 for impedance measurements under power. Large pressurized (1470 psi/100 bars) measurement tank. Shaker (100 Hz-40 KHz). An environment chamber with temperature control (-70 to +130°C) and humidity control (20-100%).

Local Environment: USEA SpA is located on via Matteotti in the northeast section of Lerici, the facility is located on a hill overlooking the town on a fairly busy road, but does not suffer from traffic noise. USEA also has access to the Italian Navy's Sarzana Lake Facility with measurement barge on a very quiet lake.

Future Plans for Facility: In connection with anticipated towed array work, facilities for such construction will be built at USEA, including a long vacuum tube for array assembly.

Facility Mailing Address: USEA SpA
via Matteotti No. 63
19030 Lerici
Italy

Local Contacts: Dr. Ing. Giancarlo Vettori, General Director
Dr. Ing. Enzo Cernich, Director of Technology
Dr. Henk A. Wivan Asselt, R&D Head
Ing. Stefano Marsilli, Acoustics Head
Tel.: Int. Oper. + 39 187 967 125

Contact for Access/Scheduling: Dr. Ing. Giancarlo Vettori, General Director, as above

Narrative Description: Ufficio Studio Elettro Acoustica (USEA) SpA was founded in 1951 to respond to the needs of the Italian Navy in the area of underwater acoustic sensors.

USEA is approximately 5 mi./8 km. southeast of SACLANTCEN in La Spezia and is located in the old fishing village of Lerici (now a popular tourist site) on the northwest coast of Italy. The plant is high on a hill overlooking the town, on Via Matteotti, a rather heavily trafficked road.

The General Director is Dr. Ing. Giancarlo Vettori and the company is organized as indicated in Figure 6-4.

USEA SpA is owned by two Italian companies, Whitehead-Motofides (WMF) and Elettronica San Giorgio (ELSAG), WMF is in turn a division of the GILARDI Group and ELSAG is a company of the Government-owned STET Group. These company interrelationships are diagrammed in Figure 6-5.

USEA does all of the transducer work for those companies shown, and the major customers for USEA are the Italian Navy indirectly and ELSAG and WMF directly.

USEA has recently incorporated another small company into its organization, Sonomar SpA, which resides in the same building and is now absorbed into the USEA organization. The Sonomar company was headed by Mr. Cernich and was also involved in building underwater acoustic systems. Mr. Cernich is now Technology Director of USEA. (See Figure 6-4.)

With the addition of the Sonomar staff, USEA now numbers appproximately 80 persons.

The kinds of work performed at USEA and the types of transducers, arrays, and systems produced are listed below with Italian Navy indentifying numbers when appropriate.

- Sensors and sensor arrays for IPD/70S, active and passive sonar (with ELSAG)
- Sensors and arrays for MD 100, passive ranging sonar (with ELSAG)
- Underwater Telephone TS 2000 for surface ships and submarines
- Emergency Transponder for submarines
- Sonar Test Set BA IPD 70
- Echo Repeaters
- Mobile Noise Range - Deployable, recoverable from surface ship
- Acoustic navigation and positioning systems
- Acoustic Telemetry Systems
- Transducers
- Hydrophones
- Underwater connectors and penetrators
- Instrumented Buoys with radio-links to ship/shore

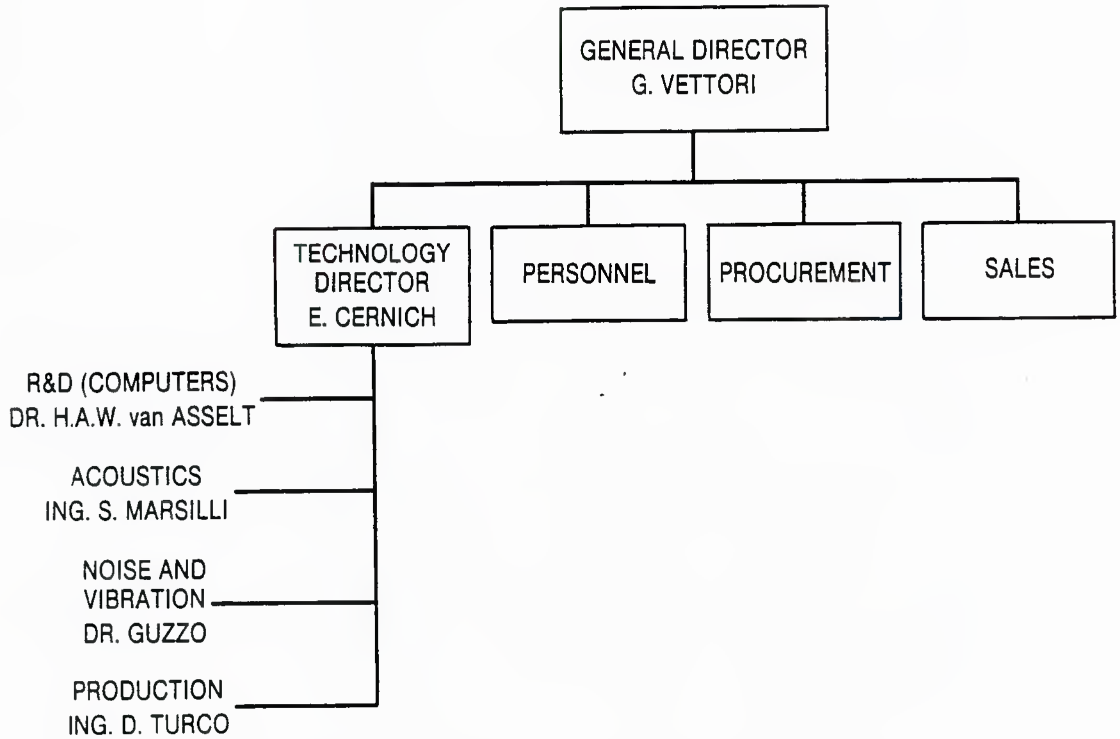


Figure 6-4. USEA SpA Company Organization

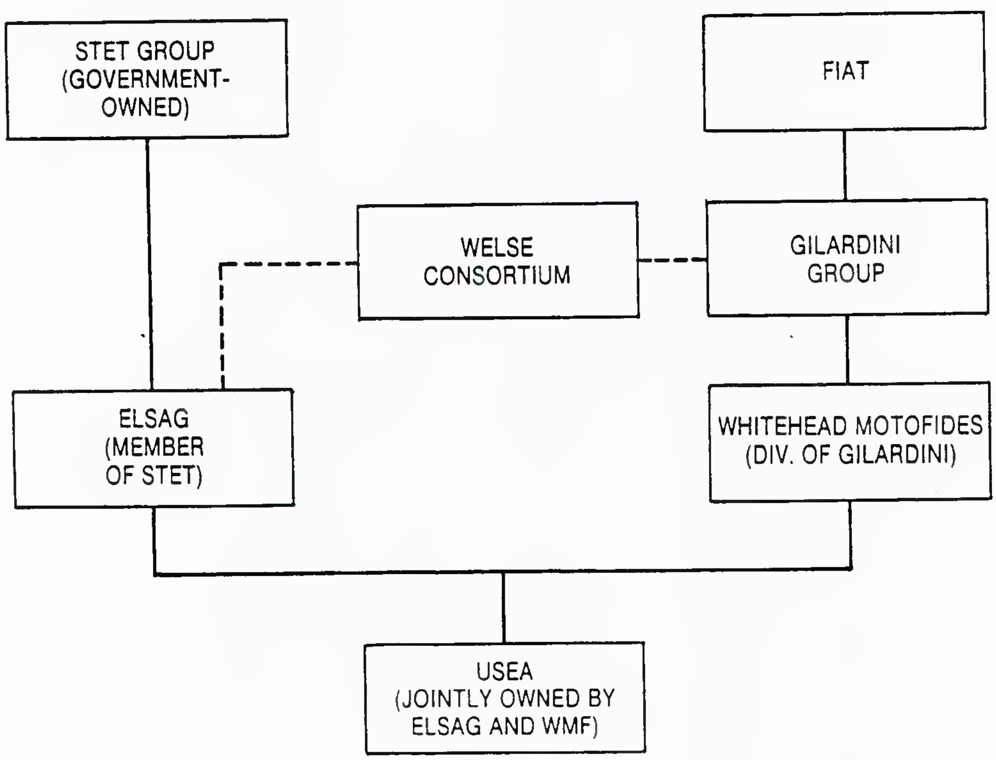


Figure 6-5. Company Interrelationships

Narrative Description (Cont'd):

Some other special systems provided by USEA are:

Target Motion Analysis System
Passive Sonar Range Prediction System
Interactive Digital Signal Processing Systems

USEA also offers customer assistance in the areas of underwater radiated noise and vibration measurement and control and in sonar performance evaluation and prediction studies.

USEA is very well equipped with acoustic measurement instrumentation and test facilities.

The largest part of the acoustic test and measurement instrumentation is centered around a recently acquired Redwood Calibration Tank (also referred to as the Ambient Pressure Tank).

The tank is circular in shape, 29.5 ft./9 m. in diameter and 23 ft./7 m. deep with a reverberation time of 180 ms. The room/water temperature is maintained at 70° F/21° C and the chlorinated tank water is filtered each night when the tank is not in use.

A monorail, mounted high above the tank, runs across the tank diameter and supports a travelling hoist with a 2-US ton/1.8-British ton handling capability.

There is a large fixed bridge 10.5 ft./3.2 m. above the water surface which supports the two rolling carriages (or dollies). The approximate tank configuration is shown in Figure 6-6.

Only one shaft is used in the USEA tank and that is a large heavy duty (2-US ton/1.8-British ton) shaft fitted with a 2-US ton/1.8-British ton Scientific Atlanta Rotator. This shaft generally is used for arrays or other large units, such as torpedo heads.

The second element, usually a hydrophone, is suspended from a davit on the smaller movable carriage shown in Figure 6-6.

A third element, which might be a standard hydrophone, can be suspended at any of several davit points along the side of the fixed bridge.

The maximum transducer/hydrophone separation distance obtainable in this tank is 19.7 ft./6 m.

The shaft can be raised and lowered to vary depth and the carriages can be moved to change distances. The shaft can be rotated 360° in azimuth and the unit under test can be tilted in pitch (±20°) and in roll (360°). Pitch and roll motion is accomplished with the use of two auxiliary shafts mounted alongside the main shaft and each controlled by its own individual motor.

The Rotator is currently controlled by an analog control system which is to be shortly replaced by a totally digital system.

Narrative Description (Cont'd):

A radio system, which can be commanded from either the older analog measurement system or the newer digital system, can control the position of the two carriages. The carriages can of course also be controlled locally, i.e., from the carriage itself.

USEA is in the process of substituting new digital instrumentation for an older analog control and measurement system used in conjunction with the Calibration Tank.

The analog system is still used in parallel with the digital system for sonic tests and is shown in Figure 6-7.

Some of the programs for the newer digital system were still being debugged at the time of the facility visit. It was intended that when all programs were running smoothly, the digital system would replace the analog system totally.

The digital control and measurement system console is shown below in Figure 6-8.

Among other significant acoustic facilities at USEA is included a large pressure vessel, capable of 1470 psi/100 bars pressure. This vessel is sketched in Figure 6-9.

The tank is filled with water at ambient pressure and is then sealed and pressurized with air from a remotely controlled pressure pump to the full 1470 psi/ 100 bars.

The tank will hold the full pressure for half an hour before re-charging is necessary. If pressure cycling is desired as part of a test, that must be accomplished manually.

The vessel wall thickness is .165 in./42 mm. and has an anechoic lining of yelutong wood absorbers.

Each of the hatch openings in the tank has a removable cover.

The cover for the smaller (19.3 in./490 mm.) hatch has a vent (and plug) opening and a cable gland to accept a single cable for the reference hydrophone.

The cover for the larger (31.8 in./808 mm.) hatch has the shaft through the center and the single transducer cable passes through the center of the shaft. The overhead hoist and the shaft can handle a maximum load of 2200 lb./1000 kg. The larger cover, while fixed in position, is fitted with attachment points for the rotator. The shaft rotation is computer controlled over 360° in azimuth.

In addition to the DEC equipment already described as dedicated to the calibration system, the computer facilities available at USEA include a VAX 750 as the main computer on which all scientific work is done.

There are also two HP 1000 Series computers with terminals and a Floating Point array processor available.

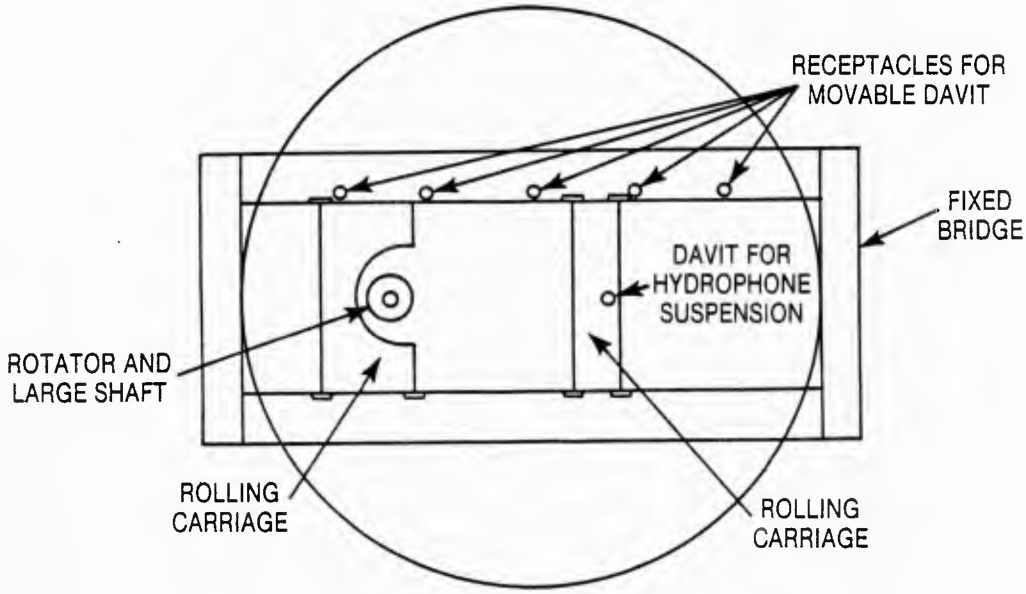


Figure 6-6. USEA Redwood Calibration Tank

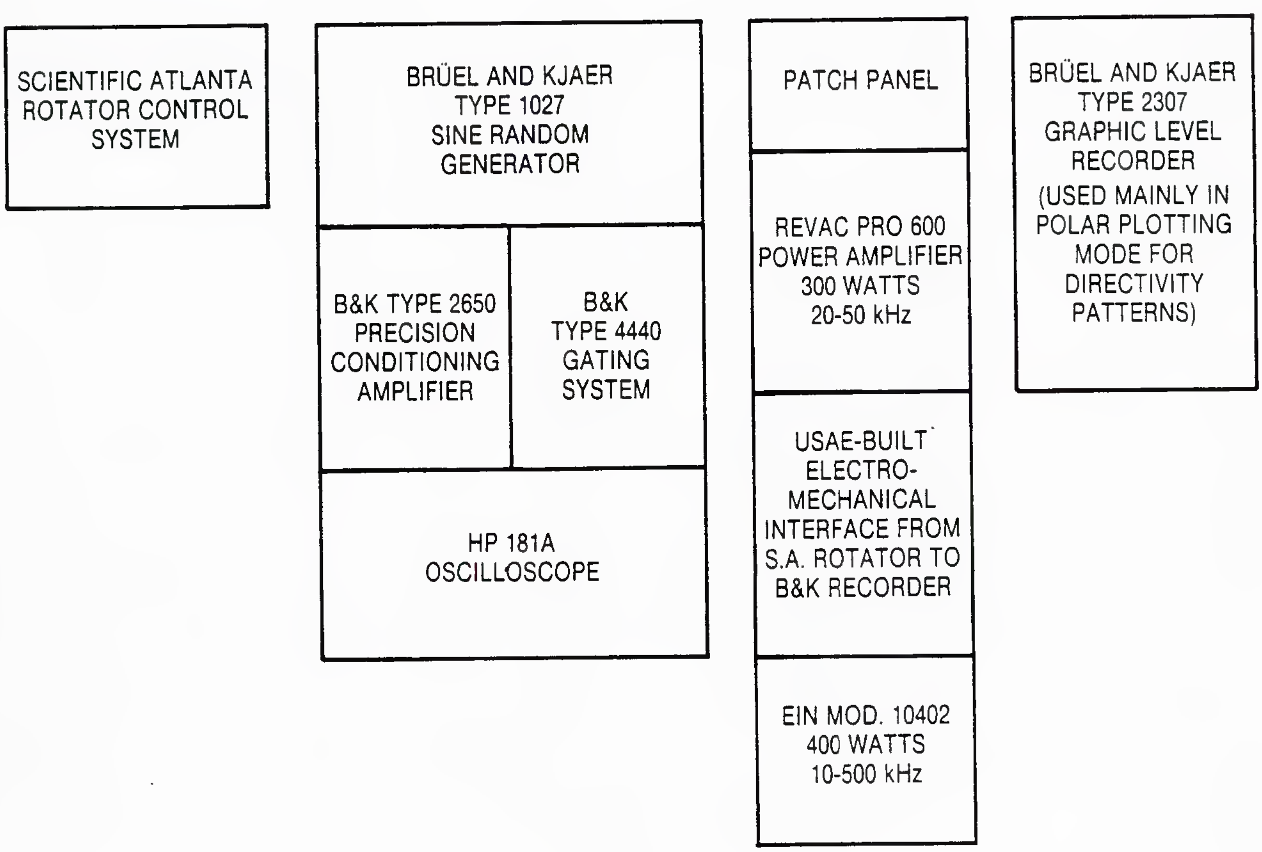


Figure 6-7. USEA Analog Instrumentation for Calibration Tank

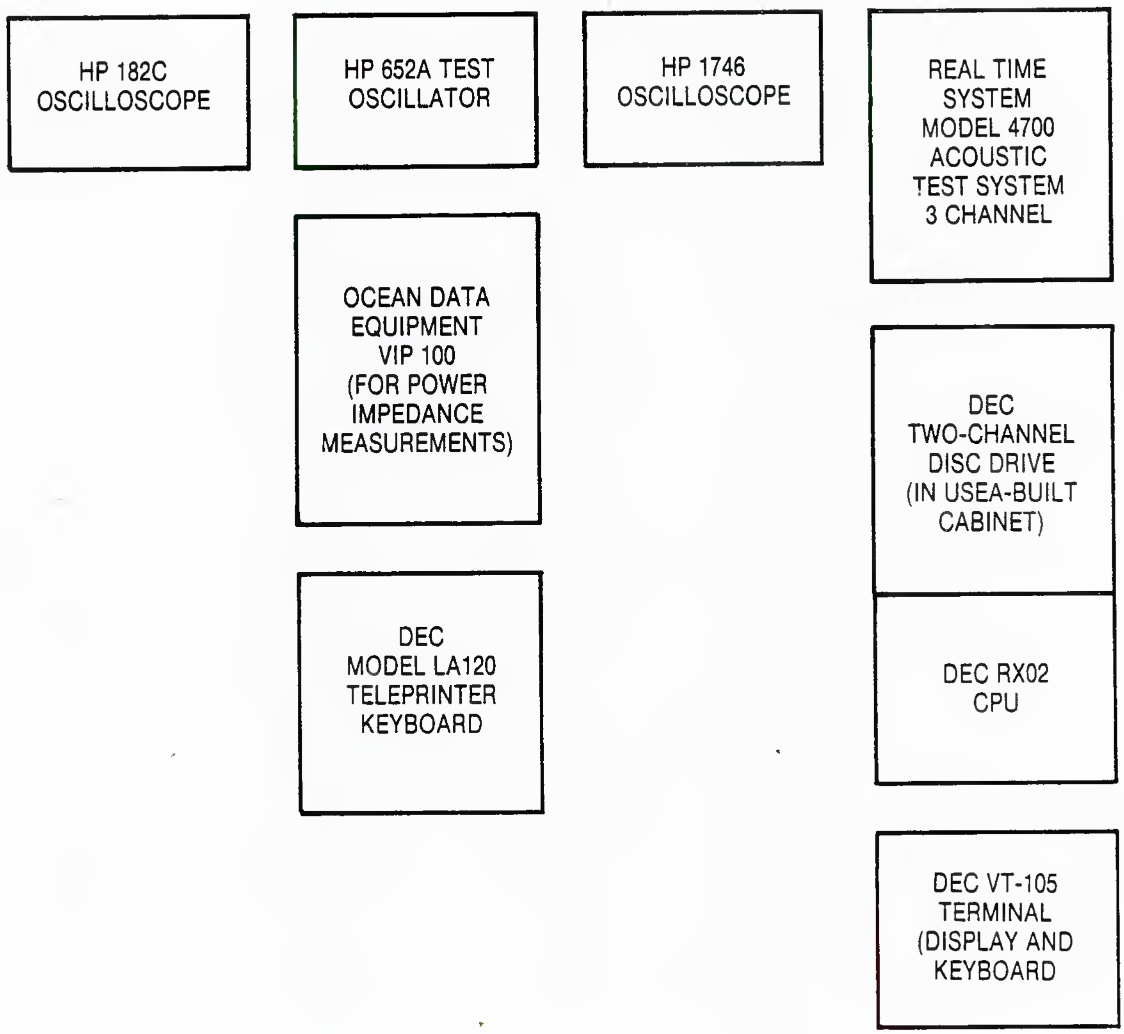


Figure 6-8. USEA Digital Control and Measurement Instrumentation for Calibration Tank

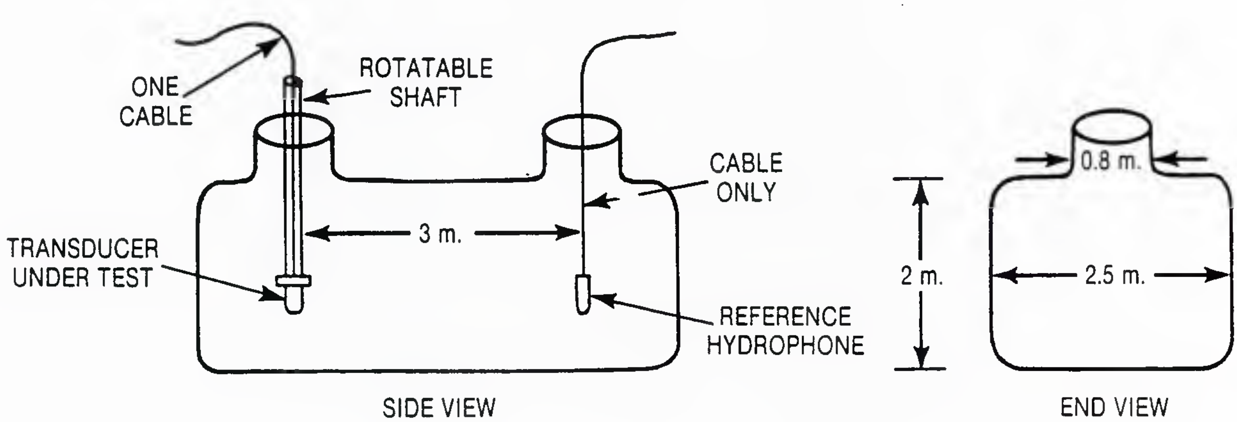


Figure 6-9. USEA Pressurized Measurement Tank

Narrative Description (Cont'd):

Other facilities available at USEA include an environmental chamber with oven temperatures up to 266° F/130° C and refrigerator temperatures down to -94° F/ -70° C. In addition, the humidity can be controlled from 20-100%. The chamber measures 3.3 x 3.3 x 3.3 ft./1 x 1 x 1 m. and is provided with programmable cycling.

A Brüel & Kjaer shaker is available with a frequency range from 100 Hz to 40 kHz. When larger vibration tables or shock tests are required, USEA makes use of the facilities of the Italian Navy at MARIPERMAN in La Spezia.

USEA is very well equipped with standard measurement instrumentation and equipment.

One such standard calibration device is a Brüel & Kjaer pistonphone calibrator.

There is also available a USEA built standing wave calibrator, used over a frequency range from 2 Hz to 2000 Hz. This cylindrical device is 4.72 in./120 mm. in diameter and stands 19.7 in./0.5 m. high. The source is located at the base and the cylinder is castor oil-filled.

A USEA-built steel pulse-tube is used for the complex impedance measurements of materials such as rubbers, neoprene, and polyurethanes. This unit is a cylinder 2 in./50.8 mm. in diameter and 6.56 ft./2 m. long. A ceramic end-plate constitutes both source and receiver.

USEA plans for the future include intentions of entering the area of towed array construction. While developing the necessary construction techniques, USEA will build an extended vacuum tube at the Lerici plant for array assembly.

Further upgrading of the computer facilities is also under consideration.

Date of this Summary
11 September 1985

Facility Name: Whitehead-Motofides, SpA

Location: On the northeast side of Livorno, near the central west coast of Italy, at 48 Via de Levante, just off the A12 Autostrada

Cognizant Organization: Whitehead-Motofides, a division of the GILARDINI Group

Facility Functional Name: Whitehead-Motofides Torpedo Launching Tests and Acoustic Measurements Pool

Major User(s): Whitehead-Motofides and USEA (ultimate customer is the Italian Navy)

Technical Areas Supported: High frequency array measurements

Unique Features: Large pool, 39 x 111 x 26 ft. deep/12 x 34 x 8 m. deep, non-anechoic, fitted to handle torpedos for launching tests and for acoustic measurements; test instrumentation located in a trailer adjacent to the test pool

Significant Equipment Available: Large pool (as above) with three carriages: one with heavy-duty rotatable shaft, one carriage with light, non-rotating shaft, and one carriage with no shaft hardware; a complete Brüel & Kjaer calibration system; Scientific Atlanta spectrum analyzer; ITC projector, Edo Western projector; and B&K standard hydrophones, Types 8100 and 8101

Local Environment: Located just off a heavily trafficked thoroughfare in an industrialized zone on the outskirts of a medium-sized city (Livorno). Some acoustic noise. Some electro-magnetic interference currently at the site.

Future Plans for Facility: Building a fixture for large shaft to allow tilt and roll on torpedo heads. It is planned to enlarge the instrumentation trailer in the near future.

Facility Mailing Address: Ing. Galletti
Whitehead-Motofides, SpA
Via de Levante 48
Livorno
Italy

Local Contacts: Ing. Galletti (Manager)
Mr. Scardigli (Systems)
Mr. Chiuppesi (Acoustics) and
Mr. Pieri Boti (Marketing)
Tel: Int. Oper. + 39 586 840 0111

Contact for Access/Scheduling: Contact Mr. Galletti or any of the above at the address indicated. Clearance from the Italian Navy is required for access to the plant.

Narrative Description: Whitehead-Motofides is a division of the GILARDINI Group, which in turn is owned by FIAT and at the same time is a member of the WELSE Consortium. The relationships of these organizations are diagrammed in Figure 6-10.

Whitehead-Motofides (WMF) is an assembly company. WMF does not make any components at all.

WMF assembles torpedos and does the necessary testing, including both launch testing and acoustic testing. Tests are conducted in the pool in Livorno, working often with USEA personnel, and at sea, working with the Italian Navy.

USEA, in La Spezia, does all of the transducer work for WMF, as well as for ELSAG.

The principal acoustic facility at WMF is the large pool, built by the "System Engineering Company." The pool measures 39 x 111 x 26 ft. deep/12 x 34 x 8 m. deep and is unlined (i.e., is not anechoic).

For the purposes of torpedo launch testing, the entire edge of the pool, at the water surface, is lined with inflated plastic bumpers and a large net covers the bottom and all four sides of the pool.

The pool has one large movable carriage or "bridge" across it and two smaller carriages. (See Figure 6-11.)

The large carriage is actually part of a traveling hoist built by Zirbinati, SpA., with an (estimated) lifting capability of 40 US tons/35.7 British tons. (See Figure 6-12.)

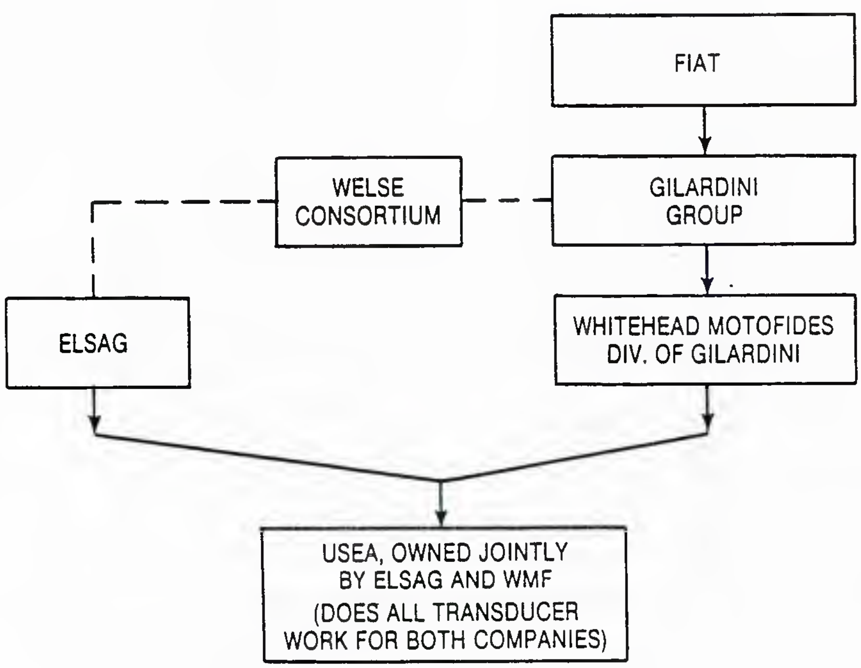


Figure 6-10. Company Interrelationships

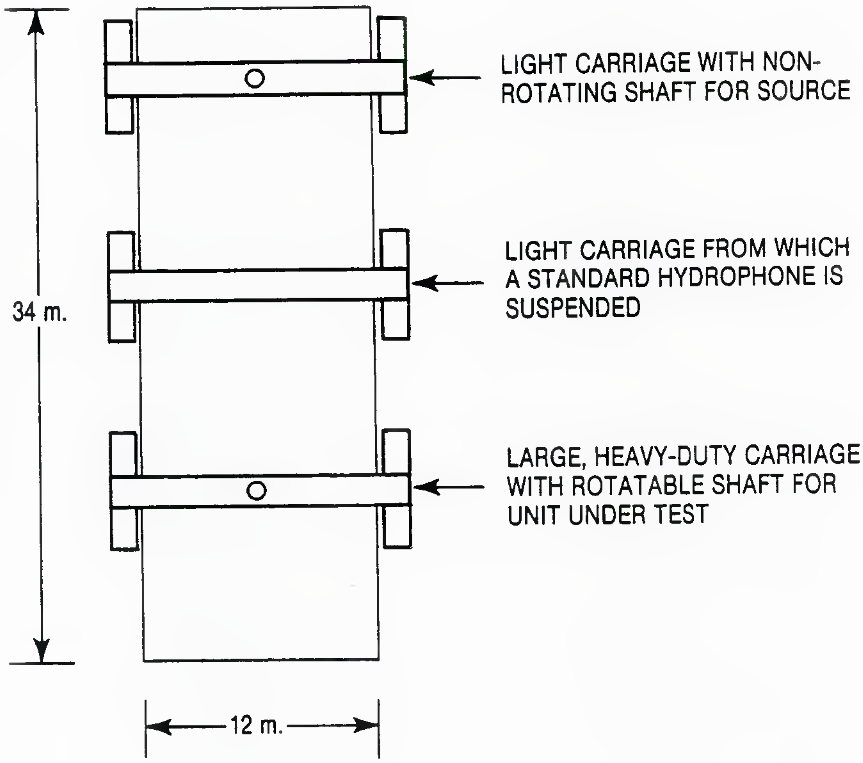


Figure 6-11. Pool Carriages

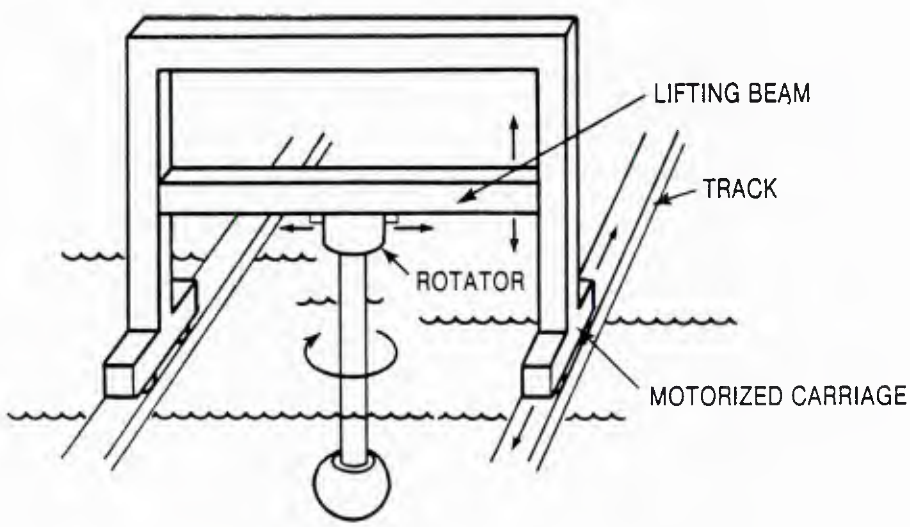


Figure 6-12. WMF Heavy-Duty Carriage

Narrative Description (Cont'd):

The large shaft normally extends 13.1 ft./4 m. below the rotator so that it is very nearly at that depth when the hoisting beam is lowered to its lowest position. The shaft can be extended to greater lengths if desired.

The shaft can be moved laterally across the pool and, of course, can be moved along the length of the pool by moving the motorized carriage. The shaft can be rotated but at this time cannot be tilted.

The traveling hoist was not initially built for acoustic tests. It is very rugged and was so constructed to be able to lift torpedos to simulate launches from a hovering helicopter.

When performing acoustic tests in the pool, short sine wave pulses only are transmitted. Source projectors at WMF are an ITC 5264 used from 10 kHz to 70 kHz (a conical unit with conical reflector which is flat from 23 kHz to 40 kHz) and an EDO Western 6194, a spherical source which is used at high frequencies and which is usable over the frequency range from 0.1-180 kHz.

The standard hydrophones (or reference hydrophones) used are the Brüel & Kjaer 8100 (reciprocal element) and the 8101 (with preamplifier).

The instrumentation for all acoustic measurements and calibrations is housed in a trailer adjacent to the test pool.

WMF has a new, all Brüel & Kjaer acoustic measurement instrumentation system. This B&K system includes:

- Power Amplifier
- Sine Random Generator
- Measuring Amplifier
- Band Pass Filter
- Gating System
- Conditioning Amplifier
- Graphic Level Recorder (Linear/Polar)

In addition, a Scientific Atlanta Mod. 375 Spectrum Analyzer is available, normally used only for processing torpedo launch data.

Future plans call for an increase in the size of the instrumentation trailer and for a modification to the large shaft, which will allow torpedo heads undergoing acoustic tests to be given a range of tilt angles and roll angles.

Date of this Summary
13 September 1985

Facility Name: Electtronica San Giorgio (ELSAG SpA)

Location: West of Genova city center at No. 2 Via Puccini, in Genova-Sestri (Sestri district of Genova) just outside the entrance/exit to the Genova Civil Airport (Cristoforo Colombo)

Cognizant Organization: ELSAG SpA is a member company of the state owned STET Group and is also a member company of the WELSE Consortium.

Facility Functional Name: ELSAG Genova-Sestri fabrication, assembly and testing facilities

Major User(s): ELSAG and the Italian Navy

Technical Areas Supported: Fabrication and testing of naval systems. Sonars, trainers, sonar stimulators, torpedo arrays, firing systems, and ROVs

Unique Features: Very large environmental chamber, EM shielded room, chemistry laboratory, mechanical test laboratory, spectroscopy laboratory, photographic laboratory for masters of circuit boards, automatic wave soldering equipment, torpedo array test jigs, large computer selection

Significant Equipment Available: Metrology center, electro-deposition equipment for metal on metal, large vacuum curing tank for polyurethane, torpedo acoustic array test jig, well equipped machine shop (largely computer controlled), two pressure test vessels, shaker tables, large environmental chamber, salt fog chamber, three large ovens, mass spectrometer, EM shielded room, and a very large selection of computers

Local Environment: Located in an industrial section in an outlying area (Sestri) of a large city (Genoa) adjacent to the airport and on a busy thoroughfare.

Facility Mailing Address: Dr. Eng. Luciano Balzarini
ELSAG SpA
Via Puccini 2
16154 Genova-Sestri
Italy

Local Contacts: Dr. Eng. Luciano Balzarini
Technical Manager Naval Systems Division, Underwater Dept.
Tel.: Int. oper. + 39 10 6001 523

Contact for Access/Scheduling: Dr. Eng. L. Balzarini, as above

Narrative Description: Elettronica San Giorgio (ELSAG) SpA had its beginnings in 1905 in a company known as St. George which primarily made mechanical equipment. In 1918, St. George entered the military equipment market making fire control systems and in 1969 the company was transformed into ELSAG SpA.

Narrative Description (Cont'd):

ELSAG is a member of the state-owned STET Group and a member of the WELSE consortium as well.

ELSAG Genova-Sestri has a sister plant (located in Fusaro outside of Naples) which was formerly part of Selenia and which now (since 1981) is known as ELSAG Fusaro and which constitutes the ELSAG Underwater Systems Department.

ELSAG and Whitehead-Motofides are joint owners of USEA in Lerici which provides all the necessary transducers for both companies.

The above company interrelationships are diagrammed below in Figure 6-13.

ELSAG Genova-Sestri is not actually involved in any extensive acoustic measurements. Their acoustic work is limited to quick checks on assemblies or partial assemblies to be certain that the acoustic circuits are functioning.

They do participate in the production of sonars and other acoustic systems, however, with ELSAG Fusaro, with USEA, and with WMF, and in at least one instance with Riva Calzoni.

ELSAG also conducts a great deal of testing at this plant which is essential to the production of sonar systems and other acoustic systems--such as pressure testing, environmental (heat, cold) testing, salt-fog testing, vibration and shock testing, thermal shock testing, and EMI testing. ELSAG is very well equipped in these areas.

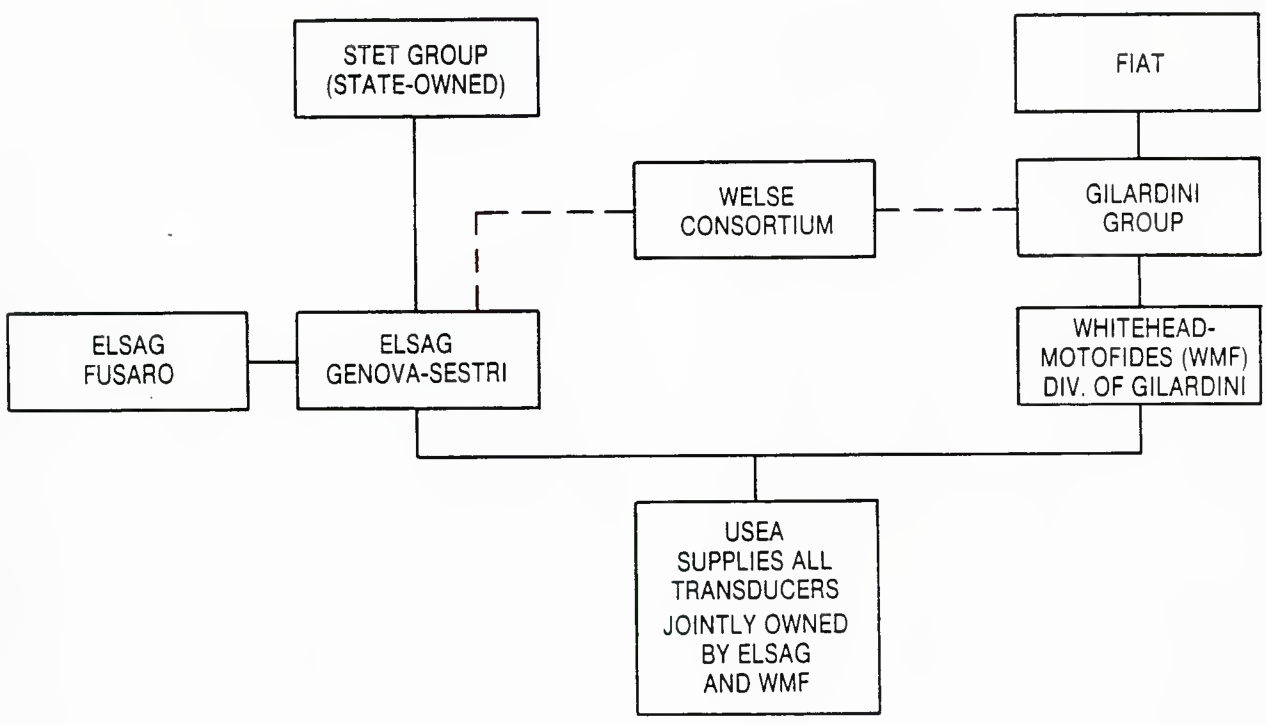


Figure 6-13. Company Interrelationship Involving ELSAG

Narrative Description (Cont'd):

ELSAG Genova-Sestri employs approximately 1870 people, of whom 650 are metal workers (cabinets, relay racks, chassis, consoles, array housings, etc.). This number is contrasted with the approximately 150 employees expected at ELSAG Fusaro in 1986.

At ELSAG Genova-Sestri, system/concept design work and all mechanical construction is performed. A large amount of the electrical production for torpedos, sonar systems, etc., is performed here including circuit boards as well as individual components. All torpedo array assembly, potting, and initial testing is also accomplished here.

No transducers or transducer arrays are produced in Genova-Sestri, but rather are produced by USEA for ELSAG. Whatever large acoustic calibration or measurement programs are required are accomplished at USEA as well.

Sonar system design and development is mainly performed at ELSAG Fusaro as well as some specific circuit and chassis design and construction, some of the electrical production work and all of the final system tests. At-sea acceptance tests are also supported by ELSAG Fusaro staff.

When hydrodynamic drag testing has been required, the towing tank and water tunnel facilities of Istituto Nazionale per studied Esperienze di Architettura Navale at the Vasca Navale (Naval Basin) in Rome have been utilized.

ELSAG Genova-Sestri produces (in conjunction with the companies mentioned above) military equipment for Naval Systems including:

- Missile and Gun Fire Control Systems
- Command and Control Systems
- Underwater Sensor Systems:
    - Torpedo Homing Heads
    - Surface Ship Active Sonar Systems
    - Submarine Active/Passive Sonar Systems
    - Submarine Intercept Systems
- Training Systems
- A Remotely Operated Mine Identification and Neutralization Vehicle (MIN)

Examples of non-acoustic systems produced by ELSAG Genova-Sestri are shown in Figures 6-14 and 6-15.

Note that another model of the NA30 system combines the same ORION-30X Radar with an Infrared Sensor and Daylight TV Camera in a single Director.

Two examples of ELSAG produced underwater acoustic related devices are given in Figure 6-16 and 6-17.

The CIACIO-5 system can be used on both heavyweight and lightweight torpedos and is reportedly effective in shallow water or in the presence of strong reverberation or multipath returns. A lightweight model is mass-produced for the A244/s torpedo by Whitehead-Motofides for several navies.

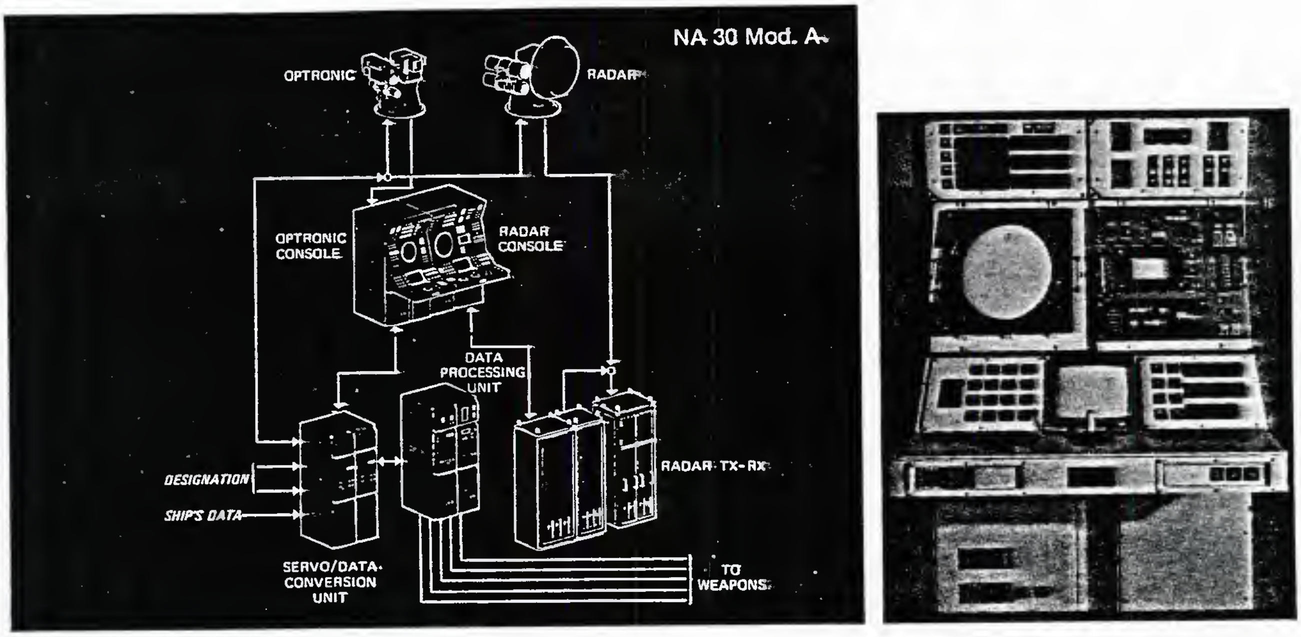


Figure 6-14. ELSAG Fire Control System NA30

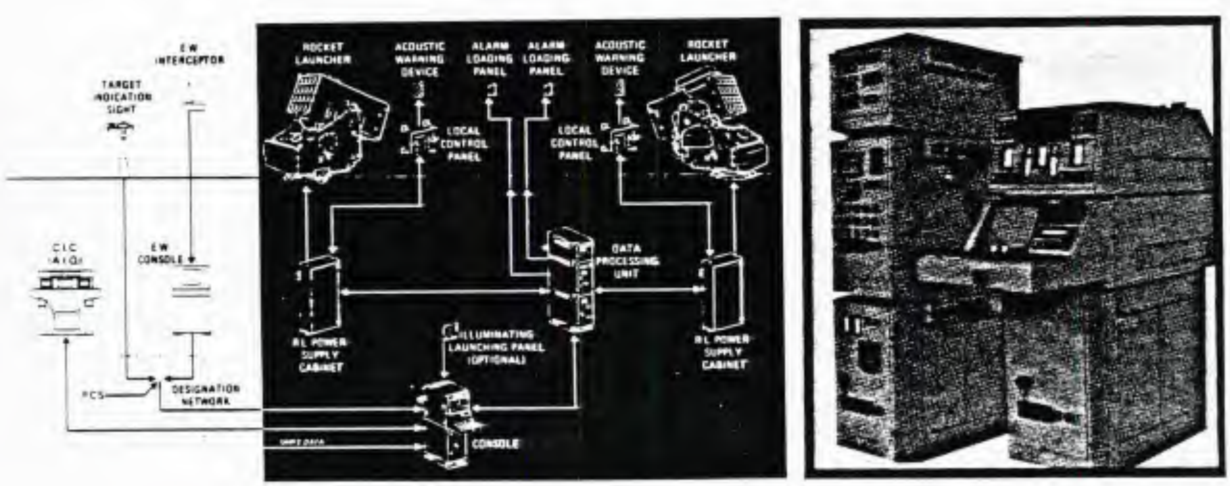


Figure 6-15. SCLAR Mk 2 Rocket Launcher System

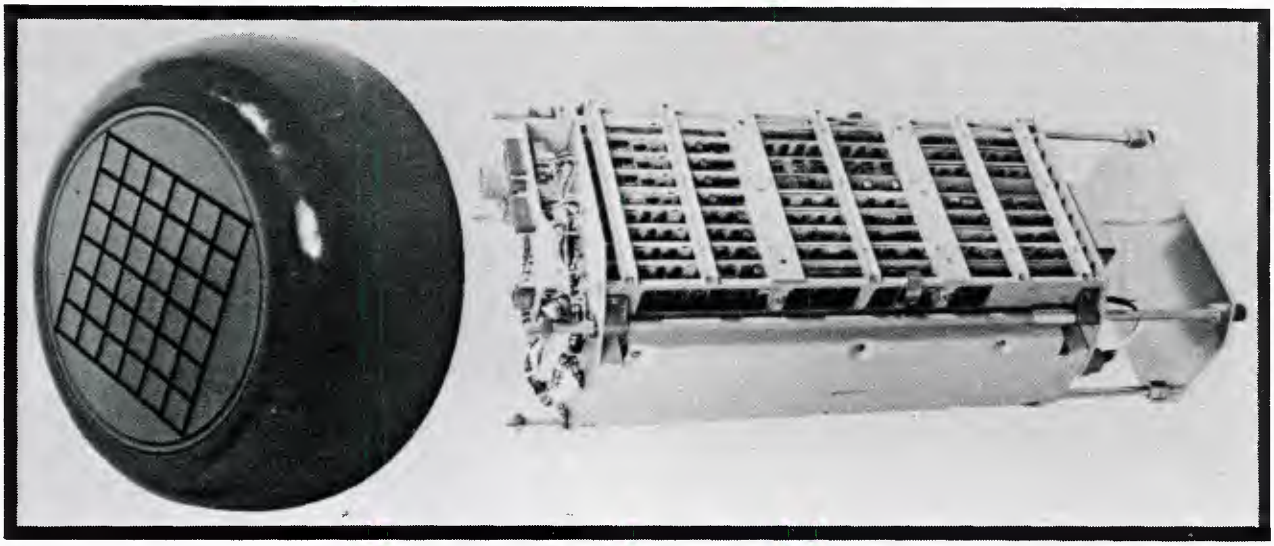
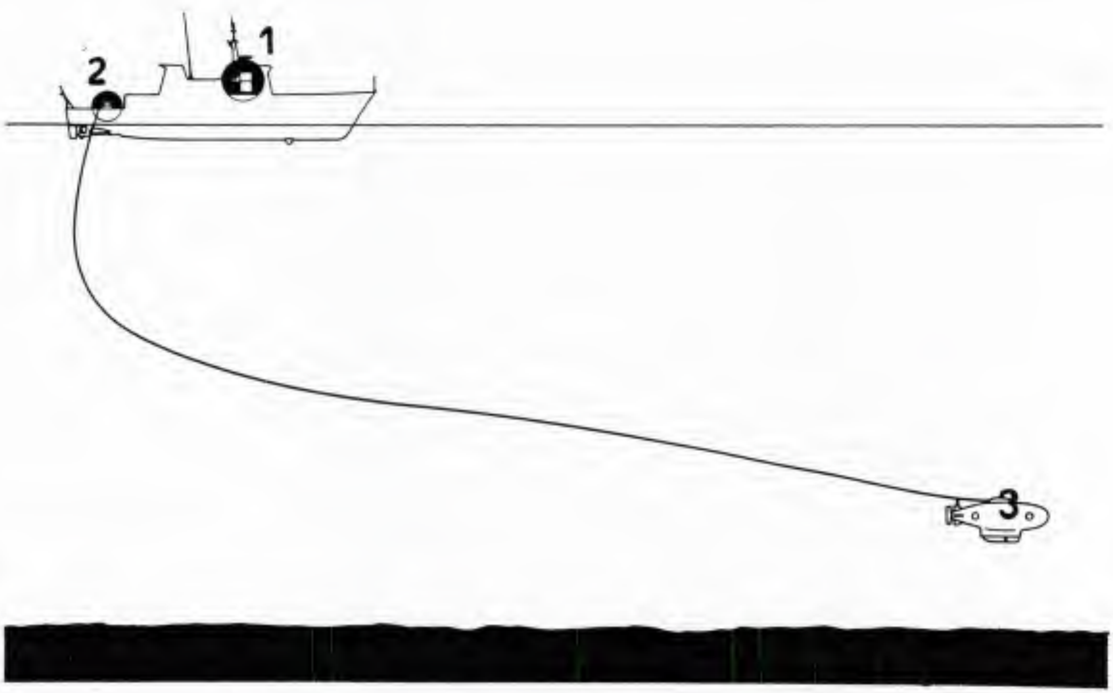


Figure 6-16. ELSAG Torpedo Homing System CIACIO-5



MIN System Components: 1 - Main console; 2 - Auxiliary console; 3 - Submarine vehicle.

Figure 6-17. ELSAG with Riva Calzoni
Mine Identification and Neutralization System

Narrative Description (Cont'd):

The MIN System shown in Figure 6-17 is being produced for the Italian navy for installation on the new GRP Minehunters (LERICI Class).

The system is essentially a submersible vehicle remotely controlled from the minehunter surface vessel. (See Figure 6-18.)

The MIN Vehicle carries both a bottom charge for neutralizing bottom mines and an explosive cutter for buoyed mines, both detonated remotely.

The use of variable speed hydraulic motors obviates the need for electric motors and variable-pitch propellers which allows a low magnetic signature and a low acoustic signature.

The MIN can be supplied with either sonar or TV sensors or both.

ELSAG Genova-Sestri, in conjunction with Selenia, also produces a shipborne combined air and surface search radar system.

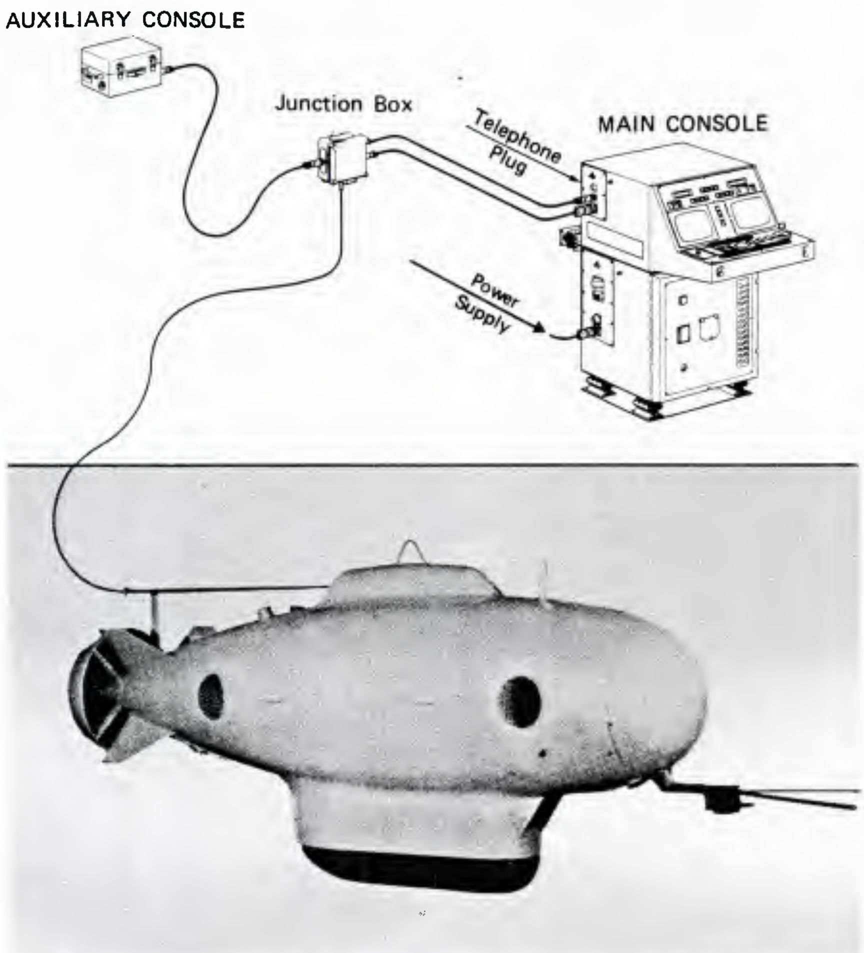


Figure 6-18. MIN Functional Diagram

Narrative Description (Cont'd):

The company produces training systems for land based sonar training. Specifically, sonar stimulators are built to inject realistic signals into a normal sonar system using a computer-controlled acoustic synthesizer. The instructor/student can select the desired ambient, the number of targets present, and the location, speed, and course of each.

One such very large system has been installed at the Italian Navy Training Center at Taranto. This system is described as "enormous," utilizing a VAX 7080 computer and five micro-computers for controlling the synthesizer.

ELSAG Genova-Sestri also produces a variety of civilian commercial equipment. Most noteworthy of these is the very large and complex automatic mail-sorting equipment which is sold the world over. (In the U.S. the equipment is licensed to Pitney-Bowes.)

The facilities at ELSAG Genova-Sestri for construction and testing are extensive; some being entirely general and some very specific for specific products.

One of the more general facilities is the Metrology Center which produces secondary standards to ELSAG and to other companies for control of dimension, orthogonality and roughness.

The plant is provided with excellent metal-working facilities: A large well-equipped machine shop with most of the machines under computer control. Complete welding and sheet metal (bending, punching, cutting and forming) shops. Facilities for electro-deposition of metals on metals and facilities for large metal surface treatment.

The chemistry laboratory is combined with a technological test laboratory and is equipped with facilites for measuring hardness, tensile strength, compressional strength and flexural strength. It is provided with thickness indicators, microphones, magnaflux equipment, and instruments for determining the mechanical properties of sonar dome materials.

In the chemistry laboratory, there is a spectrophotometer and in a separate, temperature controlled (68° F/20° C), spectroscopy room, a larger ARL 3520 AES spectrometer wih a Bausch and Lombe spectrometer plotter. This equipment is computer controlled (VAX 1220) and gives the percentage of each element present in either liquid or solid samples.

A large electromagnetic shielded room provides up to 100 dB of EM isolation. The room measures 13 x 13 x 13 ft./4 x 4 x 4 m. The facility is well equipped with a variety of antennas and is used for tests of radiated emissions, susceptibility and conductance; from low frequencies up to 1.5 GHz. The EM facility is well supplied with electronic instrumentation including the following:

HP 8568B Spectrum Analyzer with HP 7090A with a Measurement Plotting System
Solar Electronic Co. Model 6550-1 Power Sweep Generator
Solar Electronic Co. Model 8282-1 Transient Pulse Generator
Eaton 5001 Broad Band Power Amplifier (.01-10 MHz)
Eaton Advance Electronics Model NM-7A EMI Field Intensity Meter (30 MHz)

Narrative Description (Cont'd):

Pressure testing facilities include two test vessels. The larger unit is 3.3 ft./1 m. in diameter and 4.9 ft./1.5 m. high. This vessel is used at pressures up to 1764 psi./120 bars and can be temperature controlled from 14 to 122° F/ -10 to +50° C. It is provided with both pressure and temperature gauges. A 3300-lb./1500-kg. travelling hoist above the vessel can handle the heavy locking cover and heavier objects to be tested. The interior of the vessel is illuminated and there are two viewing ports in the cover. Power for the interior light is provided through a special feed-through in the cover. There are also six data feed-through connectors around the body of the vessel.

The second, smaller, vessel is 19.7 in./50 cm. in diameter and 3.3 ft./1 m. high. It has a bolt-on cover and can be used at pressures up to 735 psi./50 bars. This vessel is also provided with six feed-through connectors around the body.

For vibration testing requirements there is a 6000-lb./2727-kg. force electrodynamic system capable of sinusoidal, random, or shock tests. This system uses a Ling Dynamics air-cooled switching 24 kW amplifier (DPA 24) in conjunction with a Ling Shaker and table. (The shaker table normally provides 1 dimensional shaking in the horizontal only. An adapter does allow vertical shaking if desired.) The shaker system is located in a separate isolated space and the assembly sits on isolation mounts at the floor.

There are several special ovens available for curing, aging or hardening materials and there is a large vacuum curing tank for molded polyurethane.

Environmental testing is critical for many of the products of ELSAG and such testing receives considerable attention.

A very large environmental chamber measures 9.8 x 9.8 x 9.8 ft./3 x 3 x 3 m. and is temperature controlled from -90 to +176° F/-68 to +80° C. Humidity is controlled from 20% to 98%. Both temperature and humidity are controlled from a remote console and both are totally programmable. There is a viewing window and an access door at one end which measures 8.2 x 9.8 ft./2.5 x 3 m.

A salt fog chamber is used for materials testing of components. The chamber measures 3.3 x 3.3 x 3.3 ft./1 x 1 x 1 m. and allows the operator to preset the quantities of water and salt to be used in the test.

Three large ovens measure 6.6 x 3.3 x 3.3 ft./2 x 1 x 1 m. each and there are also several smaller sample ovens.

An oven with a power amplifier is used at temperature up to 300° F/150° C for thermal shock tests of component under power.

An EG and G Wakefield System performs automatic burn-in tests on incoming components such as transistors and silicon chips.

ELSAG has extensive facilities for the automatic design and production of printed circuit boards using Computer Aided Design programs. The process is based on interactive terminals used with a VAX 11/780 (with two disc drives and several plotters and printers).

Narrative Description (Cont'd):

A Calcomp 965 plotter produces drawings and mylar prints from which to make photo-masters of the circuits.

The Photographic Laboratory at ELSAG produces the photo-masters for the circuit boards but the photo-masters are sent outside (in Genoa or to Turin or Milan) for actual etching of the circuit boards.

There are three levels of assembly:

Manual installation of components
Computer guided installation
Computer installation of integrated circuits in cards

An automatic wave soldering machine completes the board assembly and the board is washed in a solvent (trichlorotrifluoethane) and treated with anti-fungal card coating.

One-by-one integrated circuit testing of the completed boards is also performed under computer control. A complete MIL-SPEC Library concerning electronic component/circuit testing is available at ELSAG on tape.

ELSAG has standardized their rack assemblies such that a rack holds a fixed number of drawers. Each drawer can hold either 40 standard cards or 32 cards and 2 power supplies with 6 fans. The power supplies are standardized to provide either ±5 VDC or ±15 VDC and the cards are standardized to operate off those voltages.

A special jig has been developed to check the operation of all 38 staves of the CIACIO acoustic torpedo head.

Finally, the computers in use at ELSAG Genova-Sestri are listed below.

1 Siemans - for administrative functions
1 Univac 1100/60
1 Hewlett Packard 3000
10 VAX
15 PDP
Approximately 50 personal computers: IBM, Olivetti, etc.

Date of this Summary
16 September 1985

Facility Name: Elettronica San Georgio (ELSAG Fusaro) SpA

Location: On the premises of the Selenia company, approximately 10 mi./16 km. southwest of Naples city center on a peninsula across the bay, in the Fusaro area of the Bacoli district.

Cognizant Organization: ELSAG SpA is owned by the state-owned STET Group and is a member of the WELSE consortium as well. ELSAG Fusaro is a section of the ELSAG Naval Systems Division with headquarters in ELSA Genova-Sestri.

Facility Functional Name: ELSAG Department of Underwater Activities

Major User(s): ELSAG, Italian Navy

Technical Areas Supported: Sonar systems development, signal processing systems

Unique Features: The test tank (36 x 16.4 x 30 ft./11 x 5 x 7 m.) at the plant is augmented by a mobile acoustic calibration/measurement van. The van has air conditioning and heating, is fully instrumented, and can supply 5 kW power for up to 10 hours.

Significant Equipment Available: Large, fully instrumented calibration/test tank (see above); mobile instrumented calibration/test van (see above); electronic design/construction/assembly facilities; test jig for CIACIO torpedo acoustic head; wave soldering equipment; large number of computers: VAX 1170, UNIVAC V77, Siemens 9750, 10 varied personal computers

Local Environment: The plant is located in a quiet area of a small town, close to the Mediterranean. Normal access to the sea for testing when necessary is at FINCANTIERI'S shipyard in Castellammare di Stabia, about one hour's drive.

Future Plans for Facility: It is planned to build a new and larger building in the same area in the 1987-88 period. Will provide expanded laboratory space. Will continue to use the same calibration pool.

Facility Mailing Address: Capt. Nicola Ricciardi (Manager)
ELSAG Fusaro
via Fusaro 187
80070 Bacoli
Naples
Italy

Local Contacts: Capt. Nicola Ricciardi (Manager)
Mr. Aldo de Dominicis Rotondi (Research)
Mr. Leonardo Ferreri (Design and Development)
Mr. Sergio Balzarini (Programs Coordinator)
Tel.: Int Oper. + 39 81 86 87 855

Contact for Access/Scheduling: Capt. N. Ricciardi, Manager, as above

Narrative Description: ELSAG Fusaro is part of Elettronica San Georgio SpA. ELSAG Fusaro is a remote section of the ELSAG Naval System Division which is centered in ELSAG Genova-Sestri.

The relationships among the various interacting companies involved in manufacturing and testing sonar systems, torpedo acoustic heads, and other acoustic systems are shown below in Figure 6-19.

The ELSAG Fusaro plant is a tenant activity located within the Selenia Plant in Fusaro. Fusaro is a quiet town, approximately 10 mi./16 km. southwest of the center of Naples in the Bacoli District and which sits directly across the bay from the city.

Figure 6-20 diagrams the ELSAG Fusaro organization and indicates the organizational relationships between ELSAG Fusaro and the ELSAG Headquarters in Genova-Sestri.

ELSAG Fusaro was formerly a part of Selenia, the company from which the ELSAG Fusaro plant now rents space. Selenia still provides considerable support in such areas as employee transportation (Selenia transports workers both ways in a 31 mi./50 km. radius from the plant), security building maintenance, customs, as well as such facilities as machine shops, welding, components shops, etc.

ELSAG Fusaro had a staff of 100 at the time of the survey visit in 1985 and expected to increase that number to 150 during 1986.

ELSAG does not build hydrophones or transducers or transducer arrays at either plant (ELSAG Fusaro or Genova-Sestri). That is done by USEA in Lerici, who provide all transducers to both ELSAG and Whithead-Motofides.

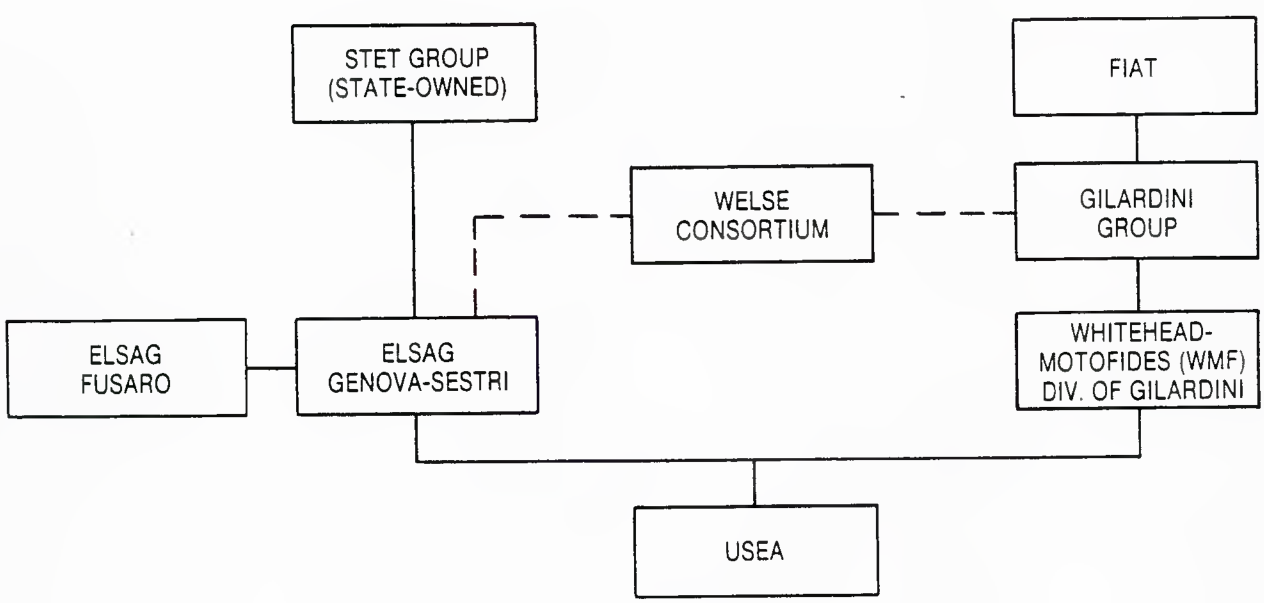


Figure 6-19. Company Relationships

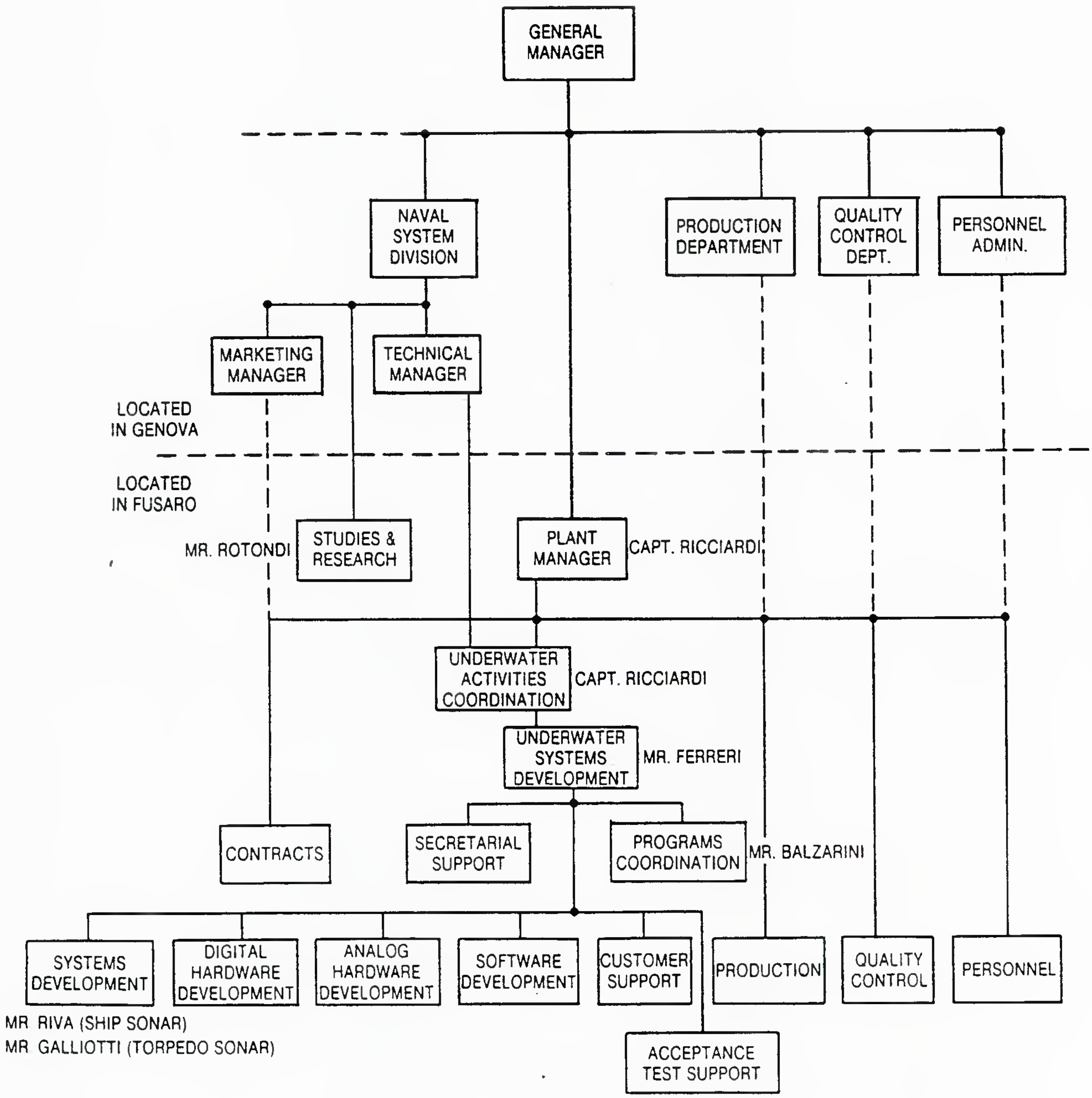


Figure 6-20. ELSAG Genova/Fusaro Structure

Narrative Description (Cont'd):

ELSAG Fusaro does design and build the electronic portions of a number of sonar systems, both active and passive and for both surface ships and submarines. Special systems are also built and tested here for the MIN (remotely operated submersible for Mine Identification and Neutralization) and for acoustic torpedos.

A summary list ELSAG acoustically related products is given in Figure 6-21.

For purposes of comparison, the Italian designations for three systems are given with the U.S. designations for equivalent systems:

DE 1160 equivalent to SQS-56
DE 1167 equivalent to SQS-58
DE 1164 would be equivalent to SQS-56 with VDS (there is no real U.S. equivalent)

For illustrations of the MIN and the CIACO Torpedo, see the entry for ELSAG Genova-Sestri.

The submarine integrated combat system (SICS C^3) console is pictured in Figure 6-22(a) with samples of the available displays in 6-22(b).

The SICS C^3 accepts and integrates information from the active topside array, the bow conformal array, the flank arrays, the passive range-finder system, as well as radar, ESM, optronic mast, search periscope, compass, log, and low light TV camera. The system also provides information to the operator on weapon status and optimum target range. It computes weapon pre-launch settings and gives guidance instruction during a weapon run.

Figure 6-23 shows the console of the IPD 70 integrated sonar for the SAURO class submarines.

The console, functional system diagram and the transducer for the DE 1167 Surface Ship Sonar are shown in Figures 6-24(a), 6-24(b), and 6-24(c) respectively.

Perhaps the most significant of the acoustic facilities at the Fusaro Plant is the large and well instrumented calibration/test tank shared with Selenia, the host company.

The tank measures 36 x 16.4 x 23 ft./11 x 5 x 7 m. deep and is provided with two bridges--one fixed and one movable.

The fixed bridge is located near one end of the tank and supports the main shaft which has a load limit of 880 lb./400 kg. The main shaft is a concentric shaft with azimuthal rotation provided by the outer unit. The transducer on the main shaft can also be rotated (tilted) from the verticle through angles up to ±45°. The main shaft is provided with a work platform which can be raised or lowered independently of the shaft, utilizing a long vertical side-screw. Both horizontal rotation and the raising and lowering of the main shaft are motorized.

	ACOUSTIC SENSORS FOR SUBMARINES	ACOUSTIC SENSORS FOR SURFACE SHIPS	MINE IDENTIFICATION & NEUTRALIZATION	ACOUSTIC HOMING HEADS FOR TORPEDOES	MISCELLANEA
PRESENT DEVELOP. & PRODUCTION	**IPD70 SONAR** Installed in SAURO Class I & II series	**MAST**—Multi Application Sonar TRAINER for DE 1160 and DE 1167 Sonar families (contract in force)	**MIN**—Mine Identification & Neutralization System developed for Italian Navy	**CIACIO/S** for lightweight torpedo in production	
NEW DEVELOP-MENTS	**IPD70/S SONAR** (New Computer & Display) • Contract began in 1983 SAURO III series **MD100 SONAR** passive ranging	**DE 1167 SONAR** (License & Cooperation Agreement with Raytheon)	**SONAR** for MIN developed for Italian Navy	**TOSO** for heavyweight torpedo **NEW GENERATION** Head for lightweight torpedo—Studies and preliminary project in progress	**ANALYSIS & CLASSIFICATION** of acoustic sources (Studies, preliminary projects and experiments **ACOUSTIC IMAGING** Studies and experi-ments in progress
NEW STUDIES	**INTEGRATED** • Acoustic Sensor System • Combat System				

Figure 6-21. Summary of Products of ELSAG Fusaro

Figure 6-22(a). Submarine Integrated Combat System (SICS C^3) Console

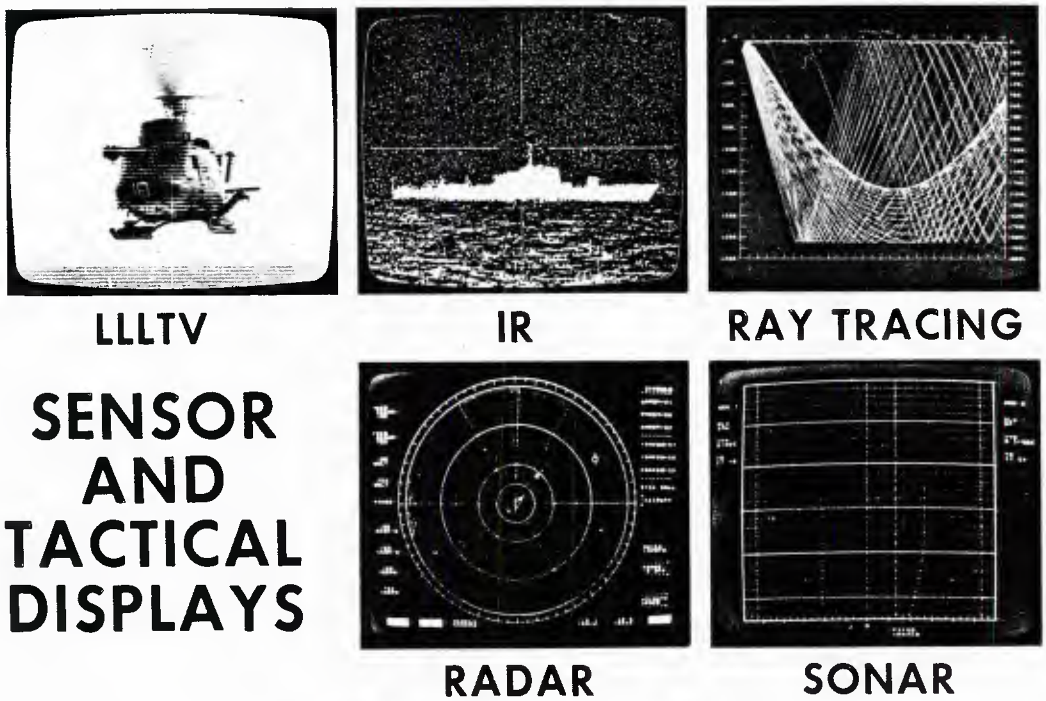


Figure 6-22(b). SICS C^3 Displays

Figure 6-23. IPD 70 Integrated Sonar Console

Figure 6-24(a). DE 1167 Sonar - Operator Console

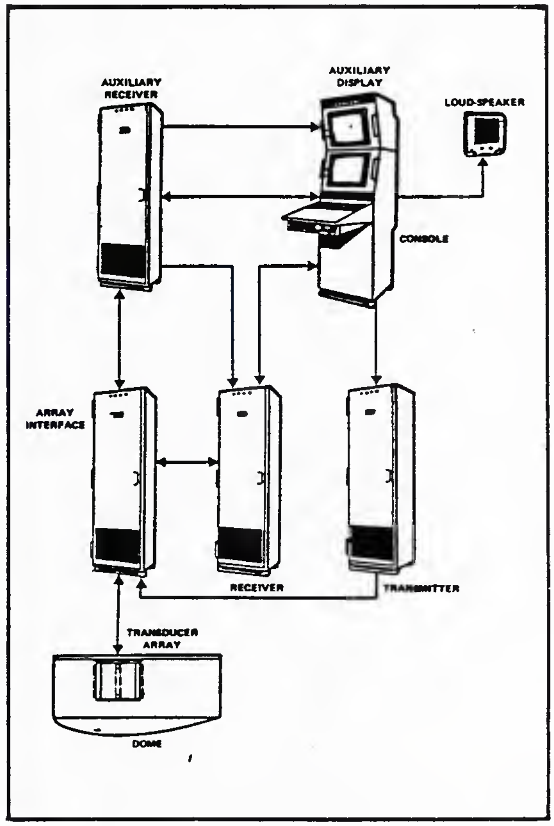


Figure 6-24(b). DE 1167 Sonar - Functional Diagram

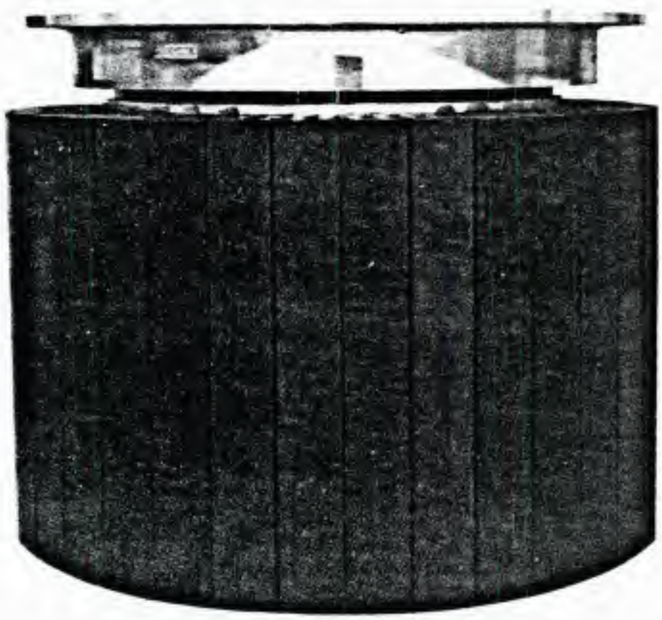


Figure 6-24(c). DE 1167 Sonar - Transducer Array

Narrative Description (Cont'd):

The transducer/array under test is normally lowered to a depth of 13.1 ft./4 m.

The second and lighter shaft is mounted on the movable bridge. It is normally used for supporting a Brüel & Kjaer 8100 standard hydrophone or other reference hydrophone or acoustic reflector or section of material to be tested.

The distance between the source and the standard hydrophone can of course be varied but the shaft on the movable bridge is fixed in position with respect to the bridge, so it cannot be moved sideways nor can it be rotated.

The standard source used in this test tank is an Edo Western 6305 with a frequency range of 20 kHz to 40 kHz.

For the calibration testing or measurement of larger units or where a greater depth is required, the ELSAG Fusaro staff make use of a test station located in the FINCANTIERI Shipyard premises in Castellammare di Stabia, about a one hour's drive from the Fusaro plant.

The test site is fixed in position and is located on the sea side of the sea wall in the shipyard. The water depth at the test site is approximately 131 ft./40 m.

A crane is available at the site with a capacity of 2200 lb./1000 kg.

The station structure and operation are essentially the same as the test tank in Fusaro. The load limit on the main shaft in Castellammare is 1100 lb./500 kg.

All electronic calibration and measurement/test instrumentation for use at the Castellamare site is permanently installed in a diesel van built in the mechanical shops at ELSAG Genova-Sestri for this purpose and is transported to Castellamare when required. (The van is also useful as a mobile test unit at other test sites.)

The van has a battery power supply system with a 5 kW motor generator set so that the following circuits are available.

24 VDC	60 A
24 VDC	100 A
115 VDC	60 A

The van is provided with heat and air conditioning and can operate off the batteries up to 10 hours in a testing mode. A work bench with all necessary test instrumentation and tools for measurement support is also included in the van.

ELSAG Fusaro enjoys a large number and variety of computers. A summary listing of such digital facilities is given in Table 6-1.

For purposes of analog data recording, there is available a Honeywell 14 channel 1 inch wide band magnetic tape recorder.

Table 6-1. Summary of Digital Computer Facilities Available at ELSAG Fusaro

MODEL	CLASS	CONFIGURATION	USE
VAX 11/750	MINI	• Main memory (2 Megabyte) • Winchester disc (400 MB) • 2 removable disc units (12 MB) • 2 printers • 1 magnetic tape unit • 1 operator console • 12 video terminals	• Software development • Research
UNIVAC V 77	MINI	• Main memory (1024 K Byte) • 4 disc units (40 MB) • 2 printers • 1 band reader • 1 magnetic tape unit • 1 operator console • 4 video terminals	• Software development (mainly in connection with the UNIVAC 1100 in Genova)
HP 9836C	PERSONAL	• Main memory (768 K Byte) • 1 thermal printer (80 CRT) • 1 color graphics terminal console	• Research
4 IBM PC	PERSONAL	Each • Main memory (256 K Byte) • 1 Winchester unit (2 MB) • 1 floppy unit (500 KB) • 1 printer • 1 terminal console	Handling of • Documentation files • Materiel Stock Shop • Materiel orders • Correspondence and (limited) documentation printing • Research • Miscellaneous
SIEMENS 9750	MAIN FRAME	• Graphic printer • 1 terminal console	• Personnel administration and accounting
2 INTEL MDS	PERSONAL	(Each) • Main memory (500 K Byte) • 1 Winchester unit (30 MB) • 1 floppy unit • 1 terminal console • Emulators	• Software development
2 HP 85	PERSONAL	(Each) • Monitor • Printer • Integrated tape unit	• Research
OLIVETTI P 6066	PERSONAL	• Video terminal • 1 floppy unit (1 M Byte) • 1 thermal printer	• Electronic cards test
SPEA LOGIT 2	TEST STATION		• Electronic card testing
SPEA AFL 70	TEST STATION		• Wiring connections testing
SPEA ST 100	TEST STATION		• Electronic card testing

Narrative Description (Cont'd):

ELSAG Fusaro has duplicates of much of the same equipment seen at ELSAG Genova-Sestri, including the same acoustic torpedo head test-jig for checking all 14 beams and 38 staves.

Much of the equipment in the Production Department is also the same at the two plants, including the wave soldering machine and the circuit board washing and treatment equipment. The large production room is also used for the construction and testing of prototype electronic circuits.

A small but adequate machine shop is available for projects that do not require the more extensive facilities of Selenia or of ELSAG Genova-Sestri.

Production plans include the hope of participating in the development and production of a new integrated sonar system for a new submarine platform expected for 1988. The new sonar system would involve the facilities of the entire WELSE Consortium (ELSAG, WMF, and SEPA) and would presumably be a 7 or 8 year task.

Facility plans include the expectation of a completely new building, approximately 38,750 ft.^{2}/3600 m.^{2} in area which would house the entire ELSAG Fusaro operation. The new building will be in the same area and is expected to be completed in 1987. There is to be a new and larger laboratory space and improved facilities in general. The same (Selenia) calibration/test tank facility will continue in use and Selenia will continue to provide the same support as currently given.

Date of this Summary
19 September 1985

Facility Name: Fabbrica Italiana Apparecchiature Radio Elettriche SpA (Soc. FIAR), Defense Division

Location: Soc. FIAR Defense Division is located in the northwest sector of Milan, at No. 93 on the via G.B. Grassi

Cognizant Organization: The Soc. FIAR Defense Division is one of four divisions of Soc. FIAR, all of which are located in Milan. Soc. FIAR is a publicly owned company which is headquartered in Milan also.

Facility Functional Name: Soc. FIAR Defense Division Technical Facilities

Major Customer(s): Military (Army, Navy and Air Forces) of Italy and other European and African countries, Italian space effort

Technical Areas Supported: Sonar systems development, radar systems, electro-optics, infra-red devices, instrumentation for space satellites, Metrology, communications via satellite

Unique Features: Extensive facilities of the Metrology Laboratory, outdoor test tank which measures 21.3 x 21.3 x 21.3 ft./4 x 4 x 4 m. with fully instrumented measurement van adjacent

Significant Equipment Available: In conjunction with the outdoor test tank there is in the van a complete Scientific Atlanta Calibration/Measurement System and a Kronhite Wide Band 50 W amplifier. At the Defense Division facilities there are 14 computers including a VAX, IBM, TI, and one Raytheon computer. There are 3 clean rooms and 4 shielded rooms, a Dynamics Laboratory for shock and vibration testing, a thermal/vacuum chamber, thermal/humidity chambers, and a salt spray environmental chamber.

Local Environment: The Defense Division is located in a heavily industrialized sector of northwest Milan just off a busy major highway.

Future Plans for Facility: The Robotics and Industrial Automation Division, which currently shares plant facilities in Milan with the Space Division, will shortly move to a new plant in Baranzate, very close to the Defense Division.

Facility Mailing Address: Soc. FIAR
Via G.B. Grassi 93
20157 Milan
Italy

Local Contacts: Mr. S. Casini, General Manager (and Acting Manager of Defense Division)
Mr. Ilario Bertelli, Special Projects
Mr. Luigi Furlan, Sonar Project Manager
Tel.: Int. oper. + 39 235 790 416

Contact for Access/Scheduling: Mr. Ilario Bertelli, as above

Narrative Description: Soc. FIAR is a publicly owned company with some 12,000 stockholders. It is structured according to product line into four divisions, all of which are currently located in Milan, Italy:

Defense Division
Logistic Support Division (Customer Service)
Space Division
Robotics and Industrial Automation Division

The company was first incorporated in 1941 for the production of radio equipment. From 1962 to 1980 FIAR was part of G.E. until in 1980, G.E. dropped all military work in Europe. Since 1980, 81% of FIAR stock has been owned by SETEMER Rome, which in turn is controlled by ERICSSON. At present (1986), about 42% of FIAR shares are quoted in the public stock exchange.

Interest in Soc. FIAR in terms of this Register entry is limited to the Defense Division which had 78% of the total company sales in 1984 and 85, with net sales of $42.6 million/80 billion Lira each year.

During the years from 1946 to 1965, this group designed and developed radar systems only. In 1965 FIAR received its first G.E. license for the production of a mine-hunting sonar, the AN/SQQ-14 sonar system. The company has been involved with sonar production to some extent ever since.

The geographical distribution of sales by the FIAR Defense Division shows:

37% in Italy
43% in other European countries
19% in Africa
1% in other

The Defense Division employs approximately 608 persons. Of them, 140 are electrical or mechanical design engineers, 270 are in manufacturing directly, 44 are in production engineering. The balance are in quality assurance, testing, calibration, inspection, and various support activities.

FIAR continues to produce the AN/SQQ-14 mine-hunting sonar and to update that system.

FIAR produces radar systems, telecommunications equipments, and other avionics and space-based electronic equipments.

FIAR currently designs and produces a variety of TV systems and displays, such as the ADNOT (automatic day-night tracker for ships), low-level light systems, infra-red systems, laser range-finders, and radar systems.

FIAR was awarded a contract with the Italian Navy for a new Mine-Hunting VDS Sonar to be installed onboard 6 new "Lerici 2" vessels.

FIAR is developing a side-scan sonar in cooperation with Plessey Marine in the U.K.

Narrative Description (Cont'd):

A new VDS fully stabilized mine-hunting sonar system is being planned for a new MCM vessel and considered for possible retrofit to all Lerici Class Vessels. (The old sonar winch would be retained for use with the new system in this case.)

A key facility in the sonar testing process at Soc. FIAR is the outdoor calibration tank (or pool). This is an unlined (not anechoic) concrete tank which measures 21.3 x 13.1 x 13.1 ft. deep/6.5 x 4 x 4 m. deep. The water in the tank is not circulated, but the tank is filled a week before a specific test and drained when the test is completed.

The main shaft was supplied by Scientific Atlanta as was the rotator and the rest of the calibration system. A maximum load of 110 lb./50 kg. can be rotated on that shaft. The shaft/rotator assembly is fixed in X-Y position at one end of the tank and is supported approximately 4.9 ft./1.5 m. from the end wall.

Transducers or arrays to be measured in this tank are handled by a hoist suspended from the center crosspiece of a dual A-frame structure on wheels. The hoist is suspended 11.5 ft./3.5 m. above the water surface in the tank and has a lift capability of 1760 lb./800 kg. The array under test is lowered on the S.A. shaft normally to a point 8.2 ft./2.5 m. off the bottom.

A smaller, non-rotatable, shaft fixed near the opposite end of the tank supports the receiving reference hydrophone supplied by G.E. at a similar depth.

The arrangement permits an entire assembled SQS-14 array to be mounted on the main shaft for testing. The rotational resolution at 400 kHz is 0.05. Side lobe levels are 25 dB down from the maximum.

The electronic instrumentation for the calibration tank is installed in a "porta-van" which is located adjacent to the tank. The calibration system was obtained largely from Scientific Atlanta along with the rotator and shaft. The S.A. system noise is stated to be 30 to 32 dB below local ambient noise. The instrumentation dedicated to the calibration tank is listed below.

Pulse Timing Generator	Mod. 1118 Scientific Atlanta
Transmitter Signal Gate	Mod. 1111 Scientific Atlanta
Preamplifier	Mod. 1117 Scientific Atlanta
Differential Amplifier	Mod. 1116 Scientific Atlanta
Azimuth Positioner	Mod. 5105 Scientific Atlanta
Sampling Digital Voltmeter	Mod. 1166 Scientific Atlanta
Paper Recorder	Mod. 1530 Scientific Atlanta
Polarization Panel	Mod. 5610 Scientific Atlanta
Wide Band Amplifier	DC 500 kHz 50 W Kronhite

Soc. FIAR obtains the ceramic required for construction of the transducer arrays from G.E. The ceramic is tested, grouped, and selected at FIAR and sent to USEA in Lerici for assembly into staves. USEA sends the assembled staves back to FIAR with 64 elements in a stave, four staves to an array; 256 elements in an array.

Narrative Description (Cont'd):

The staves are assembled into an array which is pressure tested, oil filled, evacuated, and given a final impedance check. It is at this point that the arrays are sent to the Calibration tank to obtain transmitting responses, receiving sensitivities, and pattern measurements. The selection of weighting functions for beamforming are also made while the arrays are in the tank.

The array is sent on to the Service Dept. for system assembly and for futher tests. The resident military representative will oversee an in-plant system-level acceptance test after which the equipment will be sent to a ship for installation. "Ship On-Board Test" at full speed and maximum depth and finally a "Performance Test" simulating a practical operation will be made aboard the vessel under the cognizance of Navy officers from MARIPERMAN.

One advantage to making the final tests on shipboard rather than in the test tank, is the fact that with a monitor hydrophone fixed in position on the ship, the array can be rotated a full 360° and the pattern can be examined in terms of grating lobes.

The Soc. FIAR Defense Division is well supplied with digital computing equipment. A total of 14 computers includes a VAX, an IBM, a Raytheon Computer, six Texas Instrument Computers, and five smaller units.

Other general production facilities include two large assembly areas approximately 8000 $ft.^2$/750 $m.^2$ each, one for unclassified work and one for classified assembly.

There are four shielded rooms, four burn-in chambers, three clean rooms, three Metrology Laboratories, and 68 mobile test stations (test instrumentation racks). The equipment inventory includes some 5000 electronic instruments.

The four FIAR Divisions in Milan share a common machine shop, very well equipped with 123 machine tools, mostly computer controlled. Welding and plating facilities are also available at the Defense Division.

FIAR utilizes the CADMAT program extensively. (CADMAT is Computer-Aided Design, Manufacturing and Testing.)

The wave soldering machine at FIAR is used for commercial work, but all equipment for the military is hand-soldered due to temperature restrictions.

A Dynamics Laboratory includes a Barry Varipulse "drop machine" for mechanical shock testing, and a Wolpert mechanical stress device for both tension and compression.

A Ling Altec Vibrator can generate 8000 lb./3629 kg. of thrust replicating either a sine wave input or a random function. The system amplifier driving the table has a maximum output of 8 kilovolts at 4 amperes. This system is used to test system components up to the "black box" level, either in a vertical direction or horizontally, as a slip table. Use of this system is limited by dimension so that for vibration testing of entire console or relay racks the equipment must be sent to MARIPERMAN in La Spezia.

Narrative Description (Cont'd):

There is also available a smaller MB vibrator with a thrust of 800 lb./363 kg. which uses an MB Amplifier.

A variety of environmental test facilities are available. Included are two Thermal Vacuum Chambers, used mainly in the space program. One of these will provide a vacuum of -6 Torr (1 Torr = 1 mm. Hg) over a temperature range of -58 to +302° F/-50 to +150° C. A second unit of 470 liter capacity can be used over a similar range.

One environmental test chamber combines programmable control of both temperature and humidity. Temperature can be varied from -40 to +248° F/-40 to +120° C and humidity can be controlled from 0 to 95%. This unit, built by Angelantoni of Milan, measures 3.28 x 3.28 x 4.92 ft./1 x 1 x 1.5 m.

Another smaller and non-programmable chamber also provides controlled high temperatures and humidity. This unit measures 1.97 x 2.09 x 2.13 ft./0.60 x 0.64 x 0.65 m.

Two other chambers built by Associated Testing Laboratories Inc. provide low temperature control only to -85° F/-65° C and measure internally 2 x 2 x 2 ft./ 0.6 x 0.6 x 0.6 m.

Associated Testing Laboratories also supplied a salt spray environmental chamber which measures 3.3 x 3.3 x 3.3 ft./1 x 1 x 1 m.

Soc. FIAR has three Metrology Laboratories which include 76 electrical primary standards and 54 mechanical primary standards. FIAR is certified to produce secondary standards for other companies and for the military. FIAR provides such standards for pressure, length (10^{-8} m.), weight, time (HP Rubidium Standard phase locked to primary standard), planarity (10^{-8} m.) and for angular measurement (to 1 part/million). Secondary electrical standards include resistance, DC voltage, and DC current.

In terms of facility plans it is intended that the Robotics and Industrial Automation Division, which currently shares facilities with the Space Division in Milan, be relocated to a new site near Milan, together with other functional units of the Company.

Date of this Summary
20 September 1985

Facility Name: Centro Progettazioni Elettroniche

Location: About 15 km. from the city center on the outskirts of Milan, in Cinisello Balsamo, on Via Martini 9

Cognizant Organization: CPE - an independent electronics firm, in the process of changing to a limited company with joint stock

Facility Functional Name: CPE Electronic Plant

Major User(s): Users are the CPE staff. Customers are mainly the Italian Navy and Army. The company plan is to enter the biomedical field (transducers) and the ultrasonic testing field to attract more commercial (non-military) customers.

Technical Areas Supported: Acoustic fusing for Naval weapons, rockets, underwater mines and anti-tank mines; divers' acoustic equipment for ranging, direction, and communication. There is a plan to expand into the production of biomedical transducers and ultrasonic testing systems.

Unique Features: CPE has a small calibration tank adequate for their work, which falls in the 20-100 kHz frequency band. The tank measures 6.5 x 6.5 x 6.5 ft./2 x 2 x 2 m. Using a small Apple II system for all measurements in the tank, transmitting responses, receiving sensitivities, and directivity patterns are totally automated. In addition, a set of hydrophone/transducer design programs are available for use on the Apple II computer.

Significant Equipment Available: Calibration tank 6.5 x 6.5 x 6.5 ft./2 x 2 x 2 m. usable from 20 kHz to 100 kHz, Apple II computer, keyboard, display unit, silent printer, HP plotter, linear paper recorder, digital storage oscilloscope, fluke multimeter, gating/averaging circuits, programmable waveform synthesizer, and hydrophone/projector standards

Local Environment: In an industrial area on the outskirts of Milan. (The CPE plant is one of 3000 plants in Cinisello Balsamo, about 15 km. from the center of Milan.

Future Plans for Facility: It is planned to purchase a larger computer system to replace the Apple II. It is expected that the replacement will be an IBM PC AT. There are also plans to acquire property and facilities on a lake near Florence with a shore facility, floating platforms and a small tank with the shore facility. The lake is 26-33 ft./8-10 m. deep with a mud bottom, is 656 ft./200 m. wide and 1312 ft./400 m. long, and is 9.3 mi./15 km. from Florence.

Facility Mailing Address: Centro Progettazioni Elettroniche
di Ing. Bruno Latini and C. - s.a.s.
via Martini 9
20092 Cinisello Balsamo (Milano)

Local Contacts: Dr. Ing. Bruno Latini
Dr. Gasparini
Tel.: Int. oper. + 0039 2 618 5517 4145

Contact for Access/Scheduling: Dr. Ing. Bruno Latini (as above)

Narrative Description: Centro Progettazioni Elettoniche (CPE) is located in Cinisello Balsamo, a highly industrialized area about 9.3 mi./15 km. from the center of Milan. CPE is one of 3000 industries located in Cinisello Balsamo.

CPE is a "personal company" operated by Dr. Ing. Bruno Latini, a Captain retired from the Italian Navy. The company is in the process of being changed to a limited company with joint stock.

The company is primarily an electronics firm which includes the manufacture of high frequency projectors and hydrophones. CPE manufactures all the associated electronics, including preamplifiers, filters, transmit/receive switching circuits, small amplifiers, etc. (CPE does not build the micro-processors that they use or the discriminator circuits--they are being provided by another company.)

CPE is a small company with technical direction provided by Dr. Ing. Latini and his chief engineer Dr. Gasparini.

CPE customers currently are the Italian Navy and Army, either directly or indirectly. The company hopes to expand into the bio-medical field and into ultrasonic testing and to attract more non-military customers.

The company's principal products are high efficiency transducers used in acoustic fusing for naval weapons, rockets, underwater mines and anti-tank mines as well as divers' acoustic systems for ranging, direction finding, and communications. Another main item is a divers' homing tranducer. The frequency range of interest is largely between 20 kHz and 100 kHz and that is also the usable frequency range of the company's tank facility.

Although not limited to these, CPE builds three basic transducers for the above mentioned applications:

1) An untuned cylindrical general purpose element, usually used as a source.

2) An untuned single disc element used primarily as a receiver. This element is also used, however, in underwater mines in the reciprocal mode to echo range off a noise source to establish the depth off the source.

3) A tonpilz "sandwich", used as a reciprocal element and tuned to a single frequency in the 30-90 kHz region.

As noted, CPE builds other elements as well, including one standard source element about 10 in./25 cm. long (sketched in Figure 6-25) used as a diver's homing beacon. This unit consists of 3 ceramic cylinders, mounted in line to provide the desired directivity patterns. The element is normally provided with 16 ft./5 m. of Belden Neoprene cable. The end sections are epoxy resin with a

Narrative Description (Cont'd):

rubber-like (Tiocol) material. The source level of this unit at 60 kHz is +57 dB//1 µbar (+157 dB//1 µPa).

To be used in conjunction with the above beacon source, CPE also builds a diver's directional receiving system, manually steered. This is a sandwich element to be used at the same frequency--60 kHz--with a sensitivity at 60 kHz of -62 dB//1 v/µbar (-162 dB//1 v/µPa).

The total source/receive diver's direction finding system is usable at 60 kHz to a distance of 3.1 mi./5 km.

CPE purchases ceramic material pre-formed, silvered and polarized. They buy mainly small circular plates, 0.4-2.0 in./10-50 mm., and small cylinders, 0.5-1.0 in./1.25-2.50 cm. in diameter. The plates are used mainly in the fusing for mines and the cylinders for diver's equipment.

CPE currently obtains their ceramic from two sources; "Quartz and Silice" in France and "VERNITRON" in England.

The material used is almost exclusively Lead Titinate-Zirconate (their designator P1-60).

CPE has at the Cinisello Balsamo facilities a steel calibration tank which measures 6.5 x 6.5 x 6.5 ft./2 x 2 x 2 m. Short pulse transmissions are used in this tank and measurements are made over the frequency range from 20 kHz to 100 kHz.

The calibration tank is fitted with a fixed bridge which runs diagonally across the top to support the two shafts with a separation distance of either 47.2 in./120 cm. or 31.5 in./80 cm. (See Figure 6-26.)

Reciprocity calibrations are carried out in this tank every 6 months. The CPE reciprocal standard transducer is a Brüel & Kjaer Type 8103 hydrophone, very small 2.0 x 0.4 in./50 x 9.5 mm. with a wide frequency range (0.1 Hz to 150 kHz). A Dyna Empire unit is used as the receiver only in the reciprocity checks.

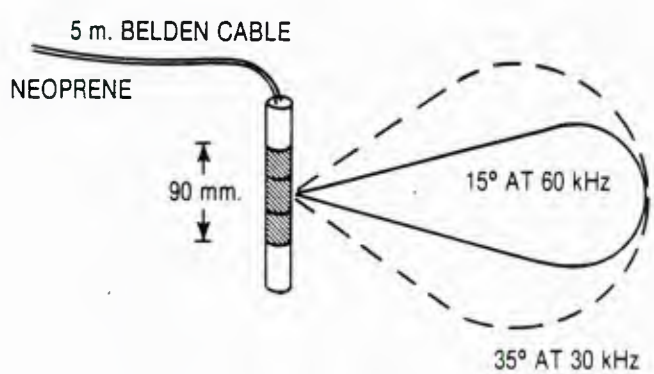


Figure 6-25. CPE Divers' Homing Transducer

Narrative Description (Cont'd):

The stepping motor indicated in Figure 6-26 advances the rotatable shaft with the test element attached one degree per step. Pulses are transmitted only when the shaft is stopped, and the shaft is normally stepped ahead one degree each second. (That is, six minutes are required to obtain the data from a complete rotation.)

The transmitted pulse length normally used is 0.5 ms. and the receiving gate is 0.2 ms.

The whole process is very stable and is totally computer controlled. The recorded/plotted data are available at the conclusion of the 360° rotation. (Directivity data are normally reported in a linear plot vice a polar plot.)

The instrumentation dedicated to the CPE Calibration Tank Transmit/Receive System is indicated in Figure 6-27.

The averager in the Gate/Averager panel shown above averages all sine peaks falling within the gate.

CPE has an excellent supply of acoustic measurement instrumentation and recorders in addition to that devoted to the Tank Calibration system.

The Apple II computer that controls the Calibration system is also used for the design of new transducers, with four programs in use for producing "sandwich" transducers. This use of computer for this purpose has proven to be extremely beneficial in terms of time saving in routine designs, particularly where small parametric changes are made and rapid turnaround is required.

Current plans are to purchase a larger and more powerful computer to replace the Apple II. Currently an IBM PC AT as a system is under consideration.

Other, more long-range CPE plans include the intent to acquire property on an artificial lake about 9.3 mi./15 km. from Florence. This lake would be in a very quiet area, with a minimum of nearby traffic and no nearby industry. There would be no boats on the lake.

The lake is elliptical in shape and is about 656 ft./200 m. wide and 1312 ft./ 400 m. long with a soft mud bottom. It is expected that calibration can be made on this lake down to frequencies in the vicinity of 300 Hz.

There would be a calibration barge on the lake as well as a shore facility which would also include a small calibration tank.

Eventually a new firm would be formed for the construction and testing for transducers of all sizes and frequencies and associated equipment.

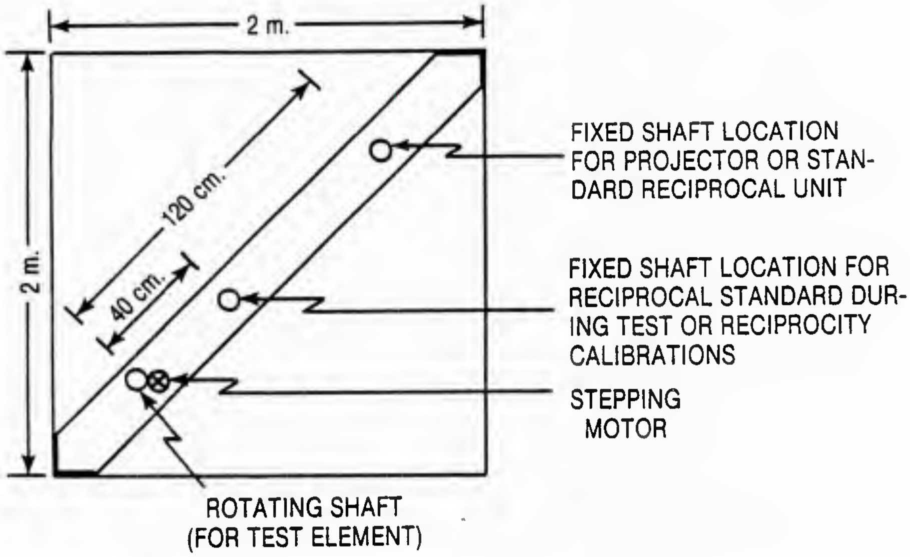


Figure 6-26. CPE Calibration Tank Top View

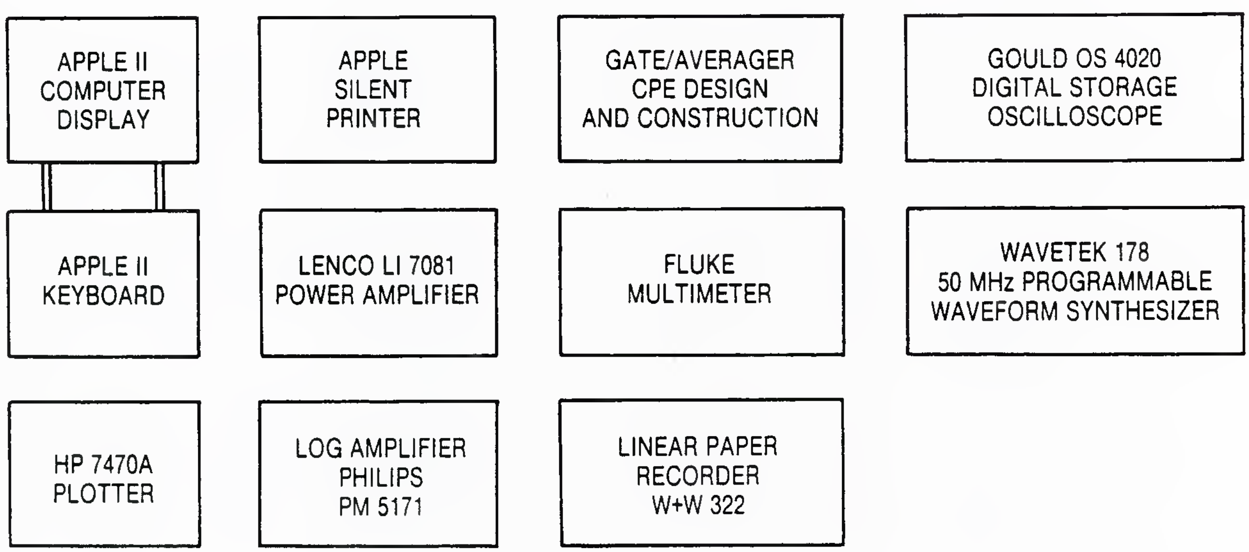


Figure 6-27. Dedicated Instrumentation

Date of this Summary
5 September 1985

Facility Name: SACLANT ASW Research Center (SACLANTCEN)

Location: The Center is on the grounds of the Italian Navy's "Permanent Commission for Experiments on War Material" (MARIPERMAN) at 400 Viale San Bartolomeo on the south side of La Spezia.

Cognizant Organization: SACLANTCEN operates under a NATO charter issued by the North Atlantic Council which places the center under the policy guidance of the Supreme Allied Command Atlantic (SACLANT).

Facility Functional Name: SACLANT ASW Research Center

Major User(s): The major users of the SACLANTCEN facilities are the resident technical representatives from the thirteen or so participating countries.

Technical Areas Supported: Transducer and transducer array development, anechoic techniques, acoustic propagation, satellite remote sensing, ambient noise (directionality), boundary interactions, seismic propagation, bottom effects, experimental environmental acoustics, physical oceanography, acoustic and oceanographic modeling, signal processing, operations research and system, concept evaluation

Unique Features: Two dedicated research vessels, R/V MARIA PAOLINA G. and the T-Boat MANNING. The scientific staff is fluid, with most members serving three- to five-year terms, and is drawn essentially from thirteen different countries.

Significant Equipment Available: R/V MARIA PAOLINA G.; T-Boat MANNING; machine shop; print shop; copying group; transducer/array laboratory; technical library; electronic laboratory; oceanographic laboratory; oceanographic instrumentation calibration facilities; acoustic calibration test tank, 15.1 x 11.8 x 8.9 ft. deep/4.6 x 3.6 x 2.7 m. deep.; towed array calibrator system; 64-element vertical array with depth sensors and multiplexer; two towed arrays and a third under construction; HP 86 computer with printer and disc drives; two pressure vessels, a third for oceanographic (deep) instrumentation under construction; Dranetz sampling network analyzer; HP synthesizer/function generator; B&K 100 W power amplifier; RCF 400 W power amplifier; B&K measuring amplifier; B&K gating system; HP structural dynamic analyzer; two Precision conditioning amplifiers; B&K rotator; B&K heterodyne analyzer; recorders; two B&K vibration analyzer systems; and ACTRAN piston calibrator. The Digital Computing Dept. has cognizance of 2 VAX 8600s, FPS-164 array processor with VAX 11/750, a separate Tempest VAX 11/750, and a number of VAX and HP minicomputers, and MAP 300 and ST-100 array processors.

Local Environment: The Center is in a quiet area on the grounds of an Italian Naval Base (MARIPERMAN) on the outskirts of La Spezia, just off a busy road. The buildings are adjacent to a shallow, quiet harbor suitable for small work boats.

Future Plans for Facility: The research vessel "ALLIANCE," a replacement vessel for R/V MARIA PAOLINA G., is under construction at a nearby shipyard. Expected to be completed in 1987.

Facility Mailing Address: c/o The Director
SACLANT ASW Research Center
Viale San Bartolomeo 400
19026 La Spezia
Italy

or APO New York, NY 09019

Local Contacts: Director (Dr. Ralph Goodman)
Deputy Director (Dr. Robert Martin)
Dept. Head for Electronic Acoustic Engineering Dept.
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(or + 39 187 540 215 for Mr. Barbagelata)

Contact for Access/Scheduling: Director or Deputy Director, as above

Narrative Description: Established in 1959, the SACLANT ASW Research Center (SACLANTCEN) is located within the compound of the Italian Navy's MARIPERMAN (Permanent Commission for Experiments on War Material) at San Bartolomeo about 1.9 mi./3 km. southeast of the center of the city of La Spezia. (See Figure 7-1.) La Spezia is a city of approximately 120,000 on the Gulf of La Spezia, a part of the northwest coastline of Italy. MARIPERMAN with SACLANTCEN is at 400 Viale San Bartolomeo and the Center building, indicated in Figure 7-2, is adjacent to a small, shallow harbor suitable for small barges and work boats. (The Center has in its main building approximately 70,000 $ft.^2$/6,500 $m.^2$ of laboratory, office, and support space and has the use of a separate warehouse structure with 14,000 $ft.^2$/1,300 $m.^2$ for equipment storage and staging. The facilities include a bank and a lunchtime canteen on the premises.

SACLANTCEN operates under a NATO charter issued by the North Atlantic Council which places the Center under the policy guidance of the Supreme Allied Command Atlantic (SACLANT) as shown in Figure 7-3.

The mission of the SACLANT ASW Research Center as specified in its NATO charter states that:

"The Centre's mission will be to provide scientific and technical advice and assistance to SACLANT in the field of antisubmarine warfare, and to be in all respects responsive through SACLANT to the requirements of NATO naval forces in this field."

As a subsidiary function, the Center renders scientific and technical assistance, within the approved technical reference, to NATO nations requesting aid with antisubmarine warfare problems.

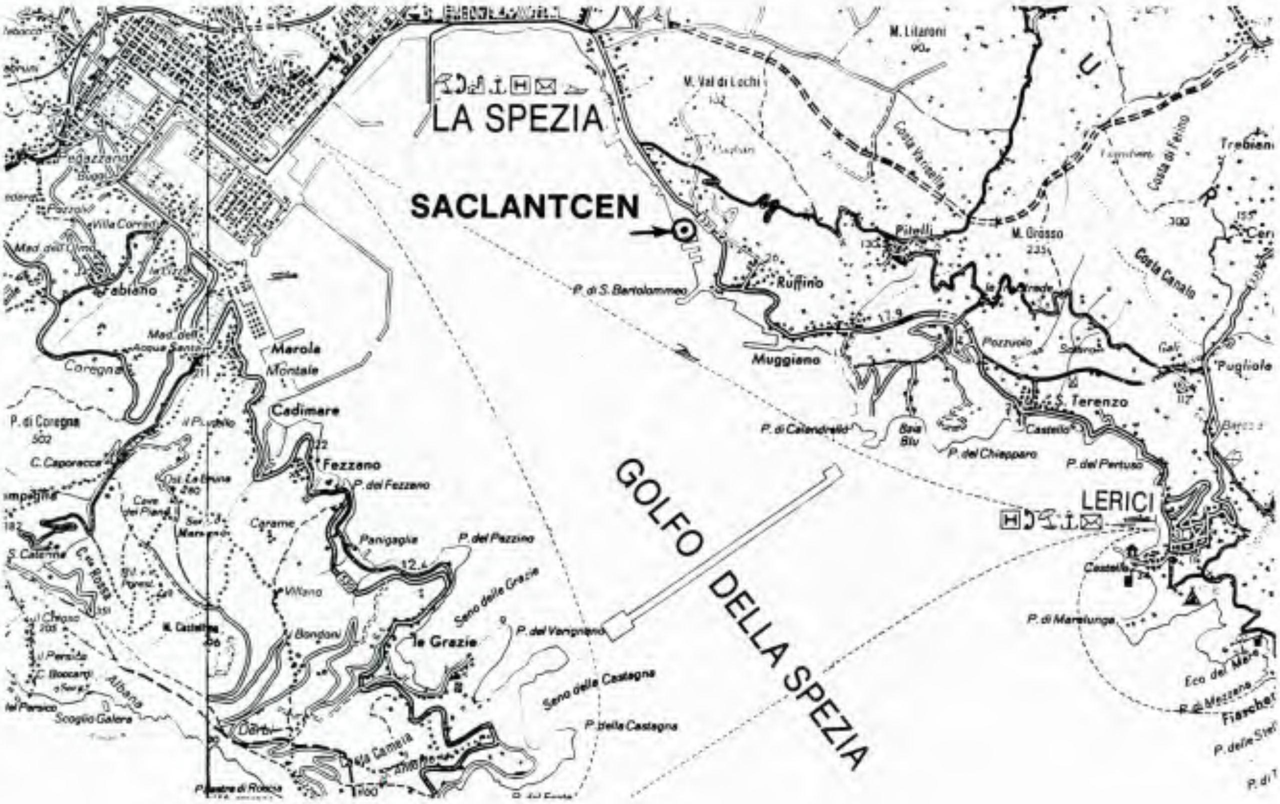

Figure 7-1. Location of SACLANT ASW Research Center

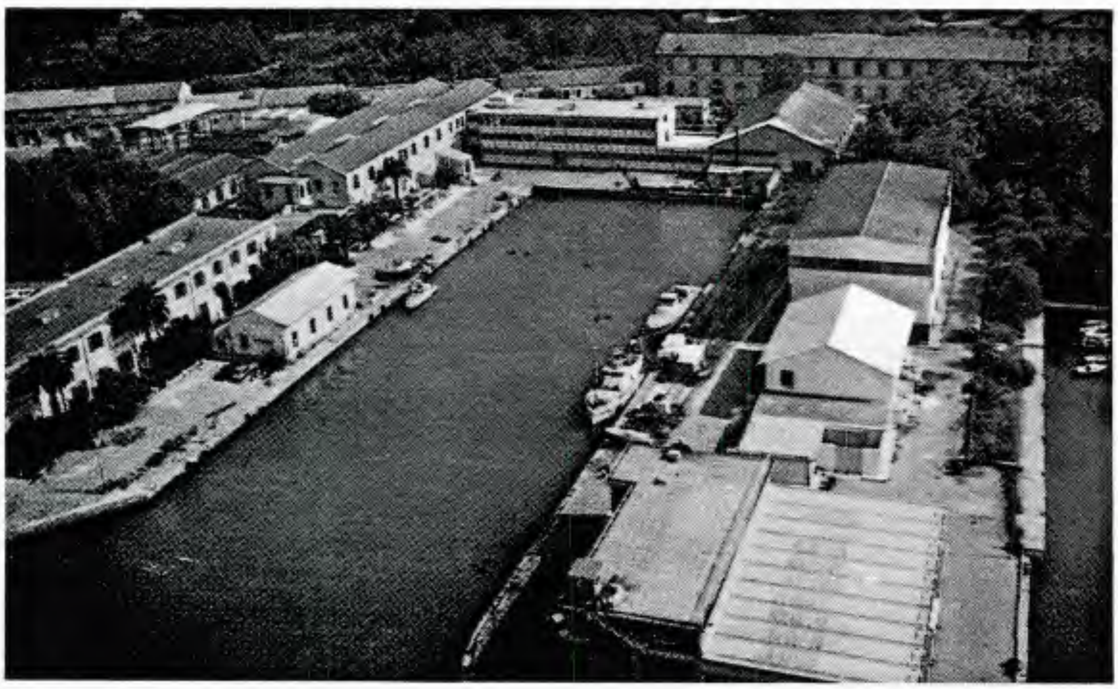

Figure 7-2. Buildings of SACLANT ASW Research Center

Narrative Description (Cont'd):

The Center performs the following functions:

(a) Operational research and analysis;
(b) Research and limited development (but not engineering for prototype or manufacture) in the field of antisubmarine warfare, including oceanography;
(c) Advisory and consultant work;
(d) Exploratory research;
(e) Such other related tasks as may be necessary.

SACLANT is assisted in determining the scope of the Center's scientific program by a Scientific Committee of National Representatives (SCNR). The SCNR is composed of highly qualified ASW scientists or engineers appointed by NATO nations. Its members meet with SACLANT representatives at least twice a year in joint session, assisted by representatives of the NATO Secretary General, the NATO Military Committee, and the SACLANTCEN Director. This ensures that the scientific program is responsive to NATO needs and avoids duplication of efforts with NATO nations. It also provides a channel that ensures easy access for SACLANTCEN to national information on ASW matters.

The internal organization of SACLANTCEN is shown in Figure 7-4.

The Director of the Center is appointed by the North Atlantic Council on the recommendation of SACLANT, following the advice of the SCNR. A Deputy Director is appointed in the same manner. SACLANT maintains at the Center a Naval Advisor to the Director, and the host nation maintains a Liaison and Security Officer.

For the conduct of the scientific program, the Director and Deputy Director are assisted by the Chiefs of the two scientific divisions: Underwater Research Division and the Systems Research Division. Within these divisions are the forty or more physicists, oceanographers, acousticians, mathematicians, computer scientists, and engineers from the NATO nations who come to the Center on limited term contracts of 3 years duration.

A significant amount of the Center's effort goes into the study of underwater acoustics, including the influence of temperature, salinity, and depth of the water column; the effect of the sea floor; the effect of marine organisms on sound propagation; and underwater noise generated by marine life, ships, and other sources.

Studies are also made of existing ASW systems and techniques and new ASW concepts are explored.

Some of the technical areas currently being investigated at SACLANTCEN are:

An autonomous, self-signalling ASW sensor system;
An active towed array system;
Experimental environmental acoustics;
The effects of the sea floor on acoustic propagation;
Numerical modeling;
Propagation of seismic waves along the sea floor;

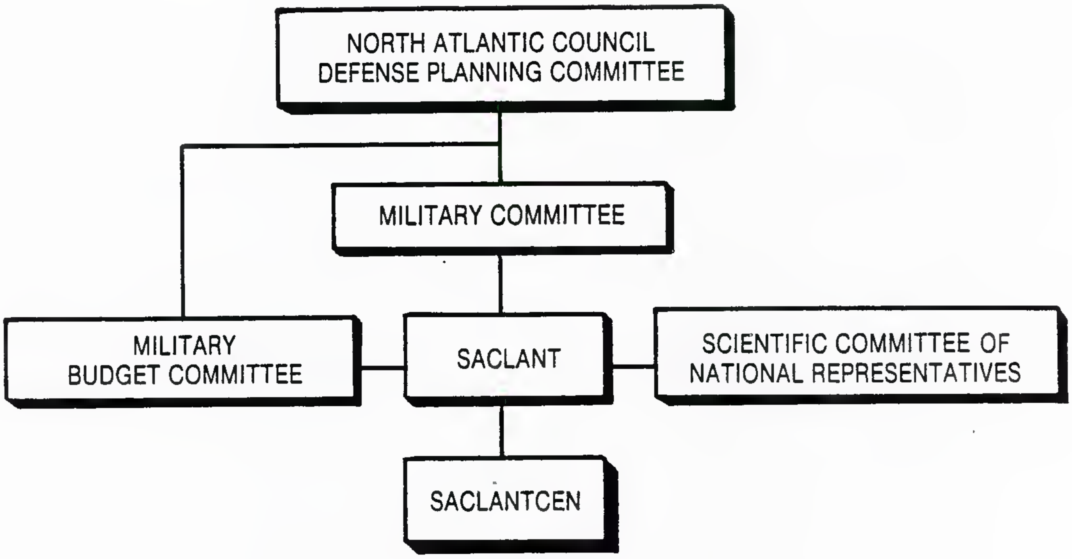

Figure 7-3. External Organization Chart

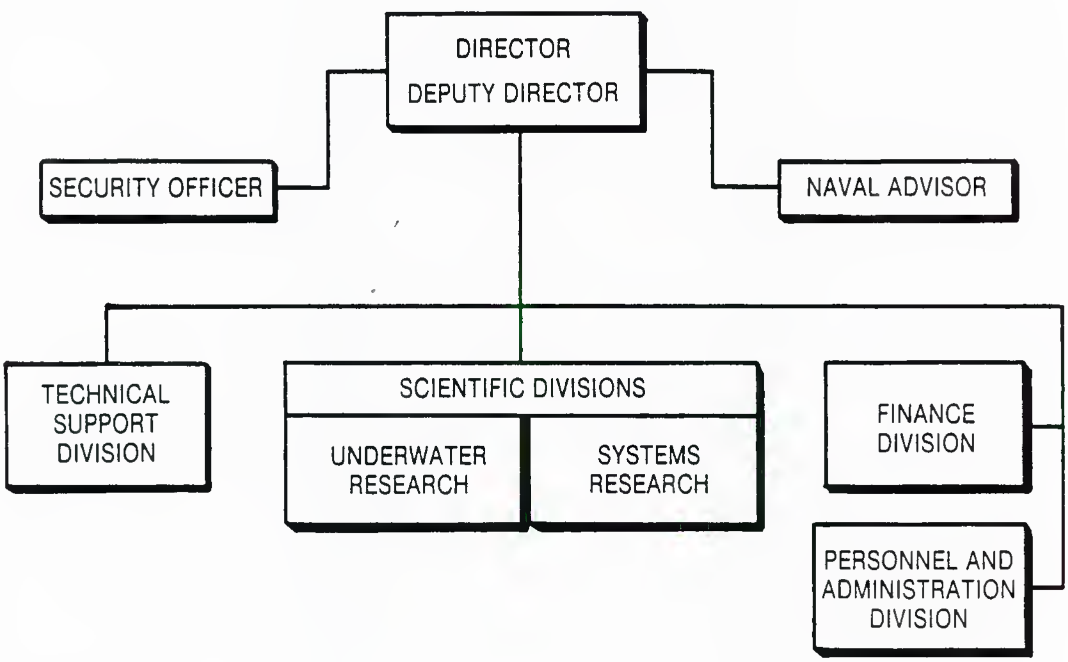

Figure 7-4. Internal Organization Chart

Narrative Description (Cont'd):

Bottom interaction and surface interaction;
Ambient noise directionality measurements;
Remote sensing;
Physical oceanography of Greenland-Iceland-Norwegian Sea area;
Operations research relative to ASW problems;
Signal processing techniques for active and passive systems.

Technical support is provided to visiting research scientists by the permanent resident technical staff of the Technical Support Division who perform the detailed design and construction of instruments or other required devices and who operate the extensive support facilities.

Such support facilities include the Scientific and Technical Information Department Facilities, the Digital Computing Department Facilities, the Ocean Engineering Department, the Electronic/Acoustic Engineering Department Facilities, and the Ship Operations Department.

The Digital Computing Department administers, maintains, plans and procures all the Center's computing resources and provides application and system programming support to the Research, Technical Support, Administrative, and Finance Divisions.

The Center's computers are broadly divided between two groups: (a) The Central Computing Facilities, consisting of two VAX 8600s for general scientific work, an FPS-164 Array Processor system supported by a VAX 11/750 for computing intensive applications, and another VAX 11/750 standalone system for secure processing. (b) The Real-Time Computing Facilities, consisting of a large set of Hewlett Packard and VAX minicomputers, MAP-300 and ST-100 array processors, and special equipment, all of which can be assembled in systems of variable complexity to meet the specialized requirements of the research projects at sea and on shore.

Most of the Center's computers and associated terminals (over 100) are interconnected through an Ethernet Local Area Network.

The Scientific and Technical Information Department manages the Center's corporate acquisition and generation of research information and some other types of program-related information. The center-point of the acquisition activity is the composite scientific/technical library and classified document section, and the generating activity is coordinated by the electronic publications and editing section. In support of the activities of the latter section there is a modest figure-drafting and photography capability, and because of their close relationship to the scientific program certain ancillary Center services, such as printing and copying and English-French translation, are also the responsibility of this department.

The special requirements of the Center's oceanographic research have created a need for instrumentation not readily available on the open market. These requirements are met by the Ocean Engineering Department, which is also responsible for the maintenance and calibration of the instruments and for their operation during experiments at sea.

Narrative Description (Cont'd):

The Department, balanced on two main branches, the oceanographic instrumentation and the mechanical one, provides also the needed mechanical support for the Center's project operations.

Main facilities available are:

a. Oceanographic calibration laboratory, well-equipped for CTD and sound speed sensors' control and calibration;

b. Sedimentological laboratory for investigation of acoustic characteristics of sea sediments;

c. Advanced computer aided mechanical design office;

d. A well-equipped machine shop which provides all in-house machining, welding, and metal-working services required at the Center.

Developments by this Department have included both long-term semi-fixed buoy systems, used to monitor deep as well as shallow currents over periods of up to two months, and ship-deployable profiling systems. Theses systems produce digitized outputs and their operation is computer controlled.

Special pieces of research equipment designed and refined during the last few years by the Ocean Engineering Department are:

a. A towed oscillating body (TOB) that measures frequent successive temperature and salinity profiles;

b. Design and construction of deep drifting acoustic Swallow floats for monitoring the circulation of ocean currents;

c. A special winch and towed sound source of variable geometry as identified in figure 7-5.

A new high-pressure test vessel is under construction which is intended for the testing of deep-going oceanographic instrumentation and which will not be provided with electrical access.

Good fiberglass working facilities are also available.

The Electronic/Acoustic Engineering Department provides all technical support of electrical, electronic, and acoustic nature to the research projects. It cooperates with the Research Divisions in the definition and specification of electronic and acoustic systems required to perform the Center's research program, and then provides for their design, procurement, calibration, testing, and maintenance, as well as ensuring their proper operation during sea trials. The Department is also responsible for purchase, administration, and maintenance of standard electronic instrumentation and transducers.

The SACLANTCEN transducer calibration facilities are under the cognizance of the Electronic/Acoustic Engineering Department. Included is an unlined metal

Narrative Description (Cont'd):

calibration tank, measuring 15.1 x 11.8 x 8.9 ft./4.6 x 3.6 x 2.7 m. deep, pressure test facilities, and the transducer section shop area.

A wall-mounted crane above the tank has a capacity of 1100 lb./500 kg. and is used to bring material from the ground level to the mezzanine level and to lower items for testing into the tank.

The tank water is routinely filtered and chlorinated.

The tank is provided with two bridges (or dollies), both movable on rollers. One of the bridges supports the main shaft fabricated at SACLANTCEN, which is fitted with the Brüel & Kjaer rotator (Type 3922 turntable). The other movable bridge supports a lighter shaft which is clamped into position on the bridge. A number of standard reference hydrophones obtained from the NRL Underwater Sound Reference Division in Orlando, Florida, are available for use on this shaft.

A Brüel & Kjaer heterodyne analyzer (Type 2010) and other dedicated instrumentation is normally used in conjunction with the tank for transmitting responses or receiving sensitivity measurements. (This would include such items as signal generators, pulsing and gating equipment, measuring amplifiers, and power amplifiers.)

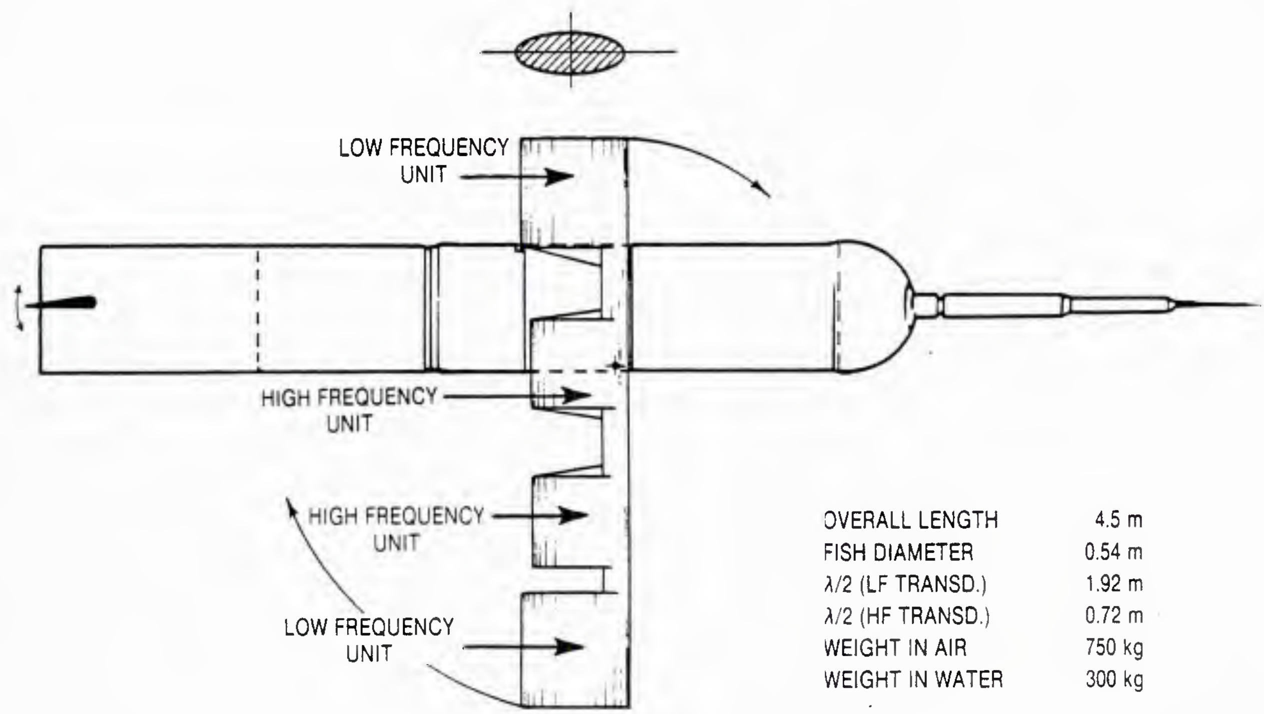

Figure 7-5. SACLANTCEN Towed Source Array

Narrative Description (Cont'd):

Related equipment located convenient to the tank and to the Transducer Section Work Area includes two Brüel & Kjaer Type 4808 vibration exciter systems with a Type 1047 exciter control and a Type 2707 power amplifier.

In the crane area is an ACTRAN Type 19 piston calibrator, used with either water or oil. This unit is used for small elements only, from very low frequencies to the low kilohertz region.

Two small pressure test vessels are available:

No.1 Inside diameter -- 6.1 in./155 mm.
Inside depth -- 19.68 in./500 mm.
Pressure capability -- 426 psi/30 bars
Equivalent depth -- 960 ft./300 m.

No.2 Inside diameter -- 6.3 in./160 mm.
Inside depth -- 15.7 in./400 mm.
Pressure capability -- 5750 psi/400 bars
Equivalent depth -- 13,123 ft./4,000 m.

The 400 bars pressure vessel is provided with electrical access.

The Electronic/Acoustic Engineering Dept. has the staff and the facilities for construction of transducer arrays. The department does make hydrophone elements or purchases the elements ready-made and assembles them into the desired array configurations. The transducer work area is supplied with curing ovens, chemical storage refrigerators, shakers, vacuum system, ultrasonic cleaning, and degreasing equipment. The group routinely does splicing and molding of both neoprene and polyurethane.

A 64-element vertical array designed and constructed by the Electronic/Acoustic Engineering Department is used in either free-floating or tethered mode by the Center normally from the R/V MARIA PAOLINA G. The array is fitted with depth sensors at both top and bottom. The 64 hydrophone elements were designed in cooperation with USEA in Lerici. A 64-channel multiplexer and A/D converter at the top end of the array transmits the signals to a surface buoy with a radio transmitter and antenna for data relay to ship or shore receiver. The link between the multiplexer and the surface buoy is selectable in length (currently 722 ft./220 m.) and consists of an armored cable with a central coaxial cable. At the lower end of the array is a large weight to aid in keeping the array vertical and at the conclusion of each test, this ballast is jettisoned through the remote operation of an acoustic release.

The Center possesses two towed arrays and currently is in the process of building a third. The new unit when completed will have an overall length of 1056 ft./322 m. and will include 256 hydrophone sensors. The hydrophones are identified as MD 3SP elements from Seismic Engineering Corp. and are approximately 3.1 in./8 cm. long and 1 in./2.5 cm. in diameter. The array will be jacketed in a polyurethane hose and will be constructed in modular sections. There are to be five modules populated as indicated below.

Narrative Description (Cont'd):

Module Identification	#1	#2	#3	#4	#5
Number of Elements	16	68	128	68	16
Spacing between Elements	6.56 ft. (2 m.)	3.28 ft. (1 m.)	1.64 ft. (0.5 m.)	3.28 ft. (1 m.)	6.56 ft. (2 m.)

By proper pairing of elements, there will be:

128 elements at 1.64 ft./0.5 m. spacing
128 elements at 3.28 ft./1 m. spacing
128 elements at 6.56 ft./2 m. spacing (nested configuration)

The preamplifiers, digitizers, multiplexer, and demultiplexer will be built at the Electronic/Acoustic Engineering Department.

Assembly of the array will be carried out by external contractors.

The two arrays already possessed by the Center include a 210-ft./64-m. long "Prakla Seismos" array built in two sections of 105 ft./32 m. each. The array is assembled within a polyurethane hose with a diameter of 2.6 in./66 mm. The hydrophone elements came from Seismic Engineering Corp. There are 128 elements with a uniform 18.9 in./48 cm. spacing. The preamplifiers for this array were also built at SACLANTCEN. Of the 128 hydrophones, 72 at a time can be used.

The remaining array, called the "Seas Array," was also built by Seismic Engineering and was recently refurbished at NUSC/New London. This array has a urethane (Pellethane) hose with an outer diameter of 3.5 in./8.9 cm. and an inner diameter of 3.27 in./8.3 cm. The overall length is 613 ft./186.9 m. and the array is constructed in three modular sections. Two VIM sections are 235 ft./71.6 m. long each and the acoustic section is 143 ft./43.6 m. long.

A number of acoustic sources are available at the Center including:

2 Honeywell HX-90, 330 Hz
2 Sanders Flextens., 400 Hz
1 Chesapeake J-9, broadband
1 General Electric DCD-26, 1 kHz
1 ITC 2010, 1 kHz
10 ITC 4001, 1.6 kHz
5 ITC 2009, 3.5 kHz
6 ITC 1000, 3.5 kHz
1 Inter-Ocean Systems, 5 kHz
(Magnetostrictive), 11 kHz
1 ITC 1032, 32 kHz
1 ITC 5132, 42 kHz
Uniboom side scan sonar

Finally, a towed source was designed and constructed at the Center as shown in Figure 7-5.

This source array contains two low frequency flex-tensional units (390 ± 50 Hz) and two higher frequency flex-tensional units (750 ± 50 Hz).

Narrative Description (Cont'd):

The array is towed in a vertical position as indicated in Figure 7-5. It is housed for storage and transport in a horizontal position and is retained in that configuration by a locking pin. The pin is removed when the array is in the launching chute so that as the assembly enters the water, it opens up under the force of gravity in a scissoring action. Towing speed with the array in the vertical position is limited to 5 knots. When the fish is retrieved, the assembly automatically closes again as it is raised from the water.

The low frequency portion of the source has been calibrated off the R/V MARIA PAOLINA G. and determined to have a source level of approximately +215 dB//µPa.

Other acoustic sources will be available through the purchase of a set of new higher frequency flex-tensional units in the frequency range of 800 or 900 Hz and through the expected return of a bender bar source from the U.K.

A line array calibrator is on long-term loan to the Center from NRL Underwater Sound Reference Division in Orlando, Florida. The calibrator was designed and built at USRD and is described in a July 1977 JASA article by Joseph F. Zalesak and W. James Trott entitled "Low Frequency Techniques for the Underwater Calibration of Individual Elements of a Line Hydrophone Array."

The line array to be measured is placed in a water-filled trough. Water is filtered and pumped through the trough to provide a constant slow circulation to avoid bubble problems.

The line array is constrained to pass through the calibrator which consists of a guide with one active element (transmitter) on each side of a single receiving element as shown in Figure 7-6.

Each element of the line array is positioned by sliding the array back and forth and peaking the signal received by the array element at 4 kHz. The calibrator receiver element is used to monitor the output of the transmitter elements. The 10 sonic resistors shown on each side of the calibrator are in fact diaphragms in silicon oil serving as acoustic absorbers to minimize standing waves in the calibrator.

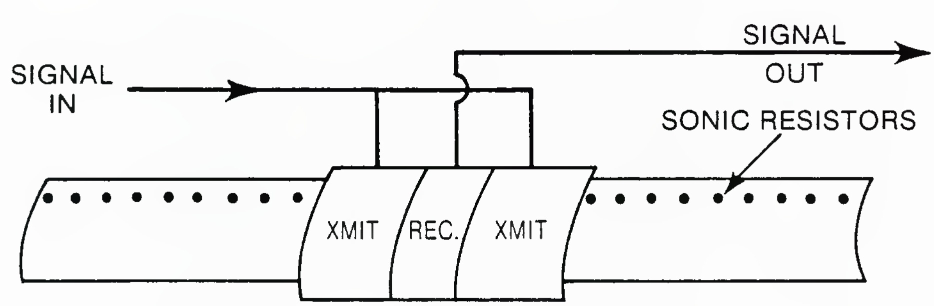

Figure 7-6. Line Array Calibrator

Narrative Description (Cont'd):

The calibrator transmitting elements have a response with a 12 dB/octave slope across the six octaves of interest for a total of 72 dB. As a consequence, an HP computer is used to control the frequency and drive level automatically in order to have a constant acoustic level around the hydrophone under test.

At the same time, the HP computer is programmed to display and to plot the desired array element sensitivity and phase and to provide automatic scaling and labelling. The process takes about 10 minutes per element.

Instrumentation used either with the array calibrator or in associated tasks includes:

- HP 86 computer with keyboard
- HP printer/plotter 9872C
- HP separate disc drives
- HP 3325A synthesizer/function generator (also under computer control)
- B&K 100 W power amplifier
- Dranetz Model 3100 sampling network analyzer
- B&K measuring amplifier, Type 2606
- Tek Dual Trace Scope

Some calibrations are performed at sea on the R/V MARIA PAOLINA G., suspending both source and receiver from the ship. (That was how the new towed sound source was calibrated.)

Some calibrations are performed on the T-Boat "MANNING" in water depths of approximately 328 ft./100 m. In this case broadband signals are transmitted and received signals are processed with an HP 5423 analyzer to provide transform functions and cross-correlations.

The facilities of the Ship Operations Department including the R/V MARIA PAOLINA G., the T-Boat MANNING, and the new SACLANTCEN research vessel will be described in the following separate entry.

Date of this Summary
9 September 1985

Facility Name: SACLANT ASW Research Center (SACLANTCEN) Ship Operations Department

Location: La Spezia, Italy

Cognizant Organization: SACLANT ASW Research Center

Facility Functional Name: Vessels under cognizance of SACLANTCEN Ship Opera-ions Department: R/V MARIA PAOLINA G.; T-Boat MANNING; and (Hull No. 921) ALLIANCE

Major User(s): SACLANTCEN scientific staff, research teams from participating SACLANT nations in conjunction with SACLANTCEN

Technical Areas Supported: Underwater acoustic propagation, boundary interactions, seismic propagation, bottom effects, ambient noise (directionality), experimental environmental acoustics, oceanography

Unique Features: Quiet ship capabilities; internal well (closed at present) (MARIA PAOLINA G.); high power amplifiers; onboard computer facilities; tunnel bow thruster (ALLIANCE); 1500 kW gas turbine silent ship generator (ALLIANCE); helicopter transfer area (ALLIANCE); large U-frame over entire stern area (ALLIANCE)

Significant Equipment Available: T-Boat MANNING: Gyrocompass; radio direction finder; LORAN-C; radar; depth sounder; HF-SSB marine band comm. radio; and VHF radio telephone. MARIA PAOLINA G.: Active rudder; sound source with launching and towing facilities; onboard HP computer facilities; data recording/processing system; power amplifiers (max 50 kW); navigational equipment; depth sounders; weather facsimile receiver; wet lab; and closed circuit TV. ALLIANCE: Bow thruster; large U-frame; 1500 kW gas generator; wet lab; diver's shop; extensive onboard computer facilities; radio communications equipment; and satellite navigator.

Local Environment: R/V MARIA PAOLINA G., when not at sea, normally ties up at the main Naval Base in La Spezia, across the harbor from SACLANTCEN. The T-Boat MANNING normally ties up in the shallow cove adjacent to the SACLANTCEN buildings at MARIPERMAN in San Bartolomeo, La Spezia. (It is not known where ALLIANCE will tie up when commissioned but presumably it will be at the same location where the R/V MARIA PAOLINA G. now ties up.)

Future Plans for Facility: The newly built Hull #921 (ALLIANCE) is to replace the older R/V MARIA PAOLINA G. as the SACLANTCEN research vessel.

Facility Mailing Address: The Director
SACLANT ASW Research Center
Viale San Bartolomeo 400
19026 La Spezia
Italy

Local Contacts: Director (Dr. Ralph Goodman)
Deputy Director (Dr. Robert L. Martin)
Dept. Head for Electronic Acoustic Engineering Dept. (Mr. Alessandro Barbagelata)
Tel.: Int. Oper. + 39 187 540 111 (or + 39 187 540 215 for Mr. Barbagelata)

Contact for Access/Scheduling: Director or Deputy Director, as above

Narrative Description: The smallest of the seagoing vessels belonging to SACLANT Center is the T-514 MANNING, with the following characteristics:

Length: 65.6 ft./20 m.
Beam: 17.8 ft./5 m.
Draft: 7.2 ft./2.2 m.
Displacement: 96 Tons
Cruising Speed: 10.5 knots
Range: 750 nmi.

The MANNING has a single diesel engine for propulsion which delivers 300 bhp.

The ship is manned by a crew of three and can accommodate a research staff of up to five maximum.

MANNING (pictured in Figure 7-7) was provided by the U.S. Government to SACLANTCEN and was previously used by Columbia University for coastal oceanographic work.

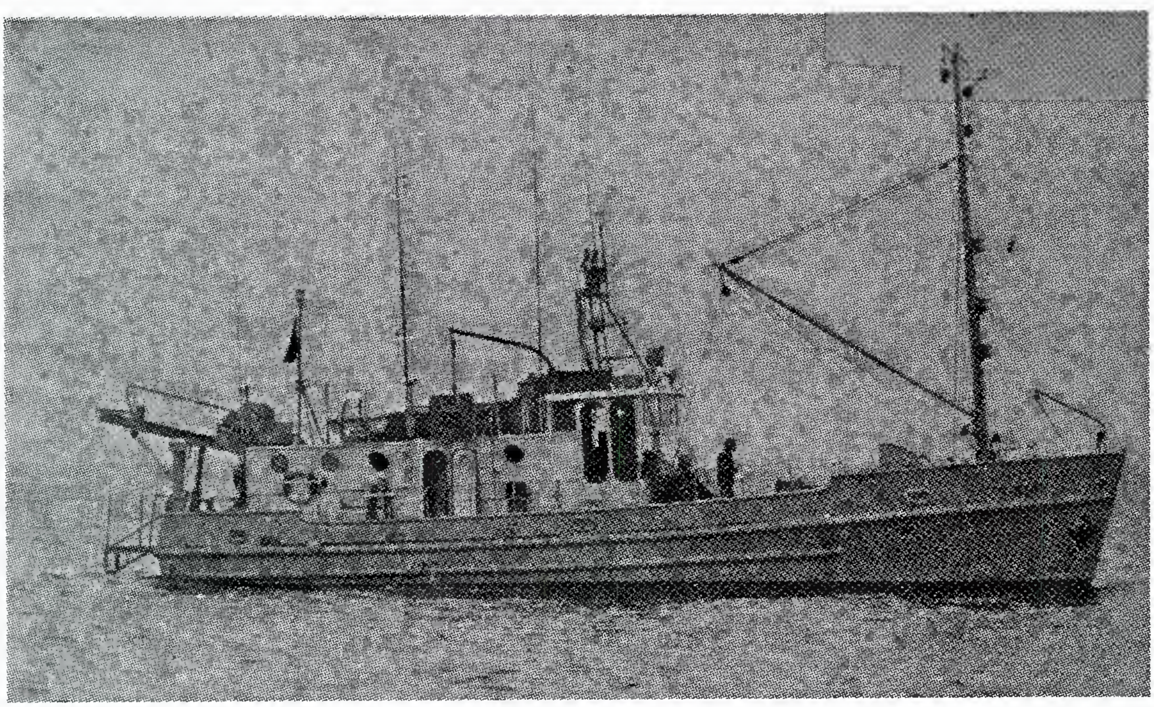

Figure 7-7. T-514 MANNING

Narrative Description (Cont'd):

MANNING facilities are summarized below.

Laboratory: The 215 ft.^{2}/20 m.^{2} forward hold is fitted as a laboratory to carry interchangeable equipment racks.

Navigation Equipment: Gyrocompass, RDF, LORAN-C, radar, depth sounder.

Communications: HF-SSB marine band. VHF commercial radio-telephone.

Electric Power: Two diesel 208/115 V, 60 Hz, 30 kW generators. 10 kW are used by static converter for 110 V dc ship's services. Iron-nickel 110 V dc accumulators for silent-ship operation.

Deck Equipment: 3260 lb./1500 kg. hydraulic winch connected to a "U"-frame at stern. 3913 lb./1800 kg. electrohydraulic 360° crane. 2200 lb./800 kg. boom.

R/V MARIA PAOLINA G.:

The larger of the seagoing assets of SACLANTCEN is the R/V MARIA PAOLINA G., currently still in use but due for replacement in the near future. The Ship Operations Department acts as the SACLANTCEN representative with the owner's of the R/V MARIA PAOLINA G. (M.P.G.) and as liaison between the management, the scientific divisions, the support departments, and the ship's masters in the preparation and use of the vessel at sea.

The M.P.G. is pictured in Figure 7-8.

The vessel is shown diagrammatically in Figure 7-9.

The ship was originally designed as a cargo ship for use on the Italy/U.S. Great Lakes run. It has been chartered from her Italian owners by SACLANTCEN since 1964. The age of the vessel with attendant increased operating costs and licensing problems dictated the construction of a new replacement vessel (R/V ALLIANCE) which is not yet available at the time of writing. In the meantime, the M.P.G. is still in use by the Center.

The dimensions and characteristics of the R/V MARIA PAOLINA G. are listed below.

Length: 263.3 ft./79 m.
Beam: 40 ft./12 m.
Draft: 15 ft./4.5 m.
Displacement: 2800 Tons
Cruising Speed: 10.5 knots
Range: 5500 nmi.

The ship carries a crew of 24 and can support a research staff of 16. Fully manned, the M.P.G. has an endurance of 22 days.

The facilities available on the M.P.G. are summarized here.

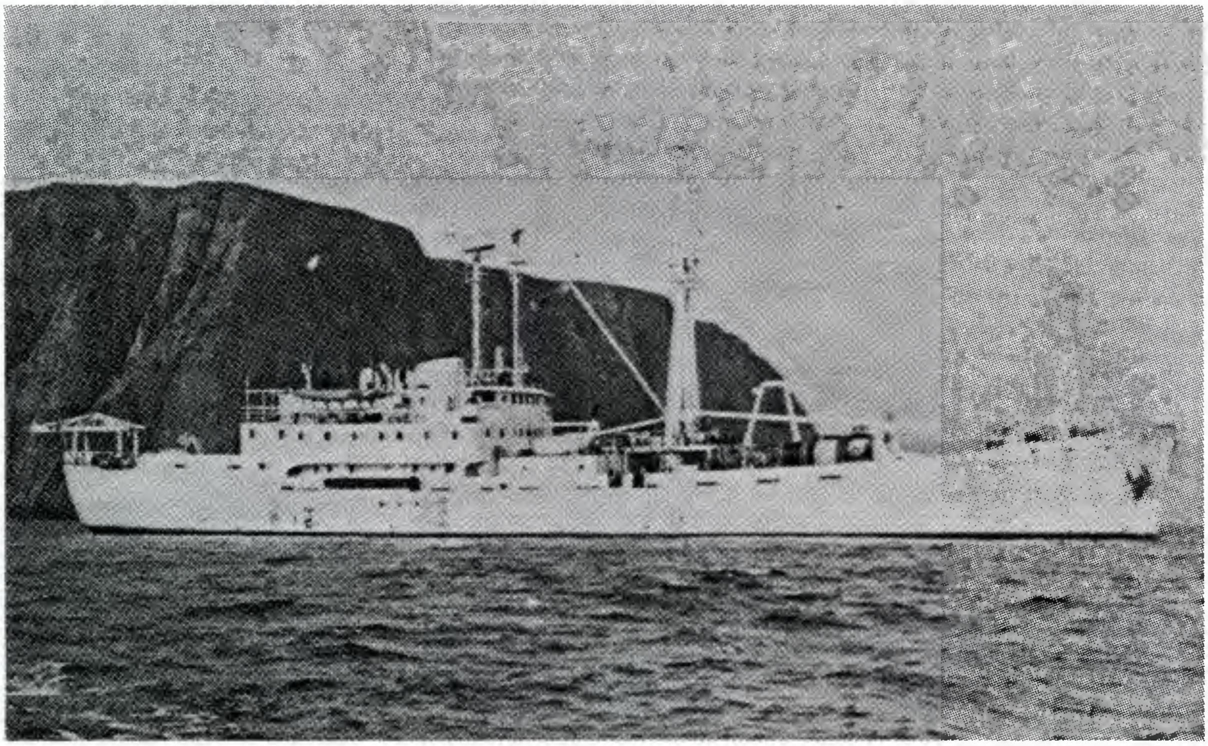

Figure 7-8. R/V MARIA PAOLINA G.

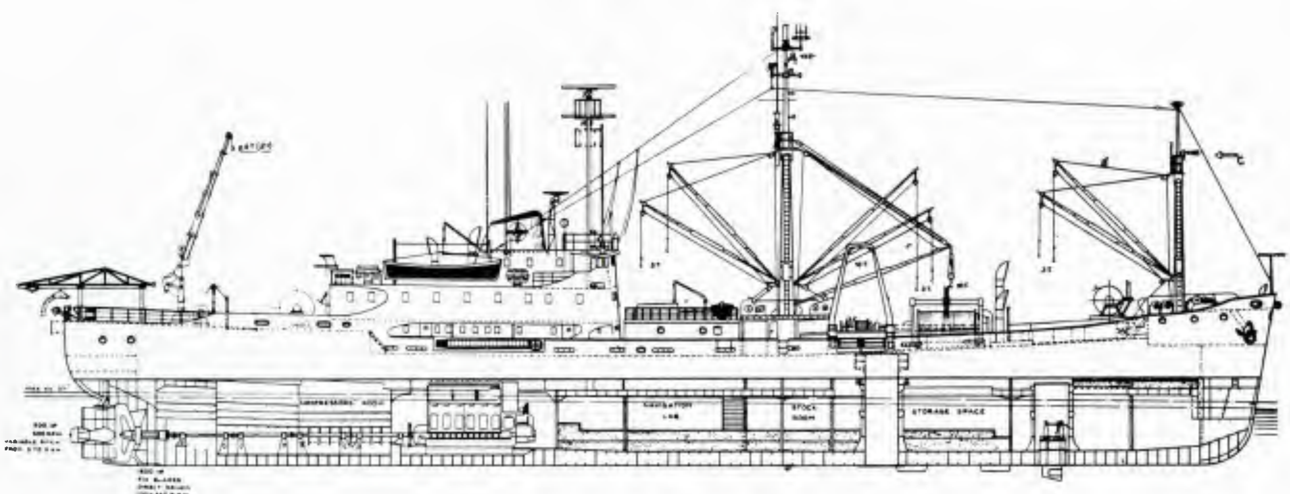

Figure 7-9. R/V MARIA PAOLINA G. in Profile

Narrative Description (Cont'd):

Laboratories: The main laboratory of about 1614 ft.^{2}/150 m.^{2}, which includes the computer facilities, is fitted with easy-loading interchangeable equipment racks to permit rapid changes in the instrumentation and their configuration. There is a smaller navigation/communication laboratory on the lower deck and an oceanographic wet laboratory on the upper deck. The laboratories are air-conditioned.

Navigation Equipment: Integrated system comprising satellite receiver, LORAN-C (RhoRho), electromagnetic log, gyrocompass, teletype interrogation with digital and graphic outputs. Automatic pilot. Radio direction finder. Three radars (one dedicated to navigation) working on X-S band, with three interswitch-controlled repeaters.

Communications: Standard merchant ship's code and voice radio links to commercial stations. In addition, HF-VHF-UHF transceivers provide voice communications with assisting ships, aircraft, and the La Spezia laboratories. Underwater telephones are used to communicate with submarines.

Electric Power: During operations at sea, noise-insulated diesel generators supply the laboratories with 208/115 V, 60 Hz electrical power. At the same time, ac-dc static converters supply the ship in place of the usual 220 V dc diesel generators.

Oceanographic Equipment: Apart from the special oceanographic equipment used for specific experiments, the ship is permanently equipped to measure meteorological parameters, sea surface data, TDS profiles, and XBT profiles; all these systems are on-line to the shipboard computer. A 12 kHz PTR/EPC 2003 bottom-profiler is also provided as standard equipment.

Onboard Computing Facilities: One or more computer systems are usually onboard the ship. They consist of a Hewlett-Packard CPU, disc and magnetic-tape mass storage, and various other peripherals. In many experiments one or two other higher performance real-time signal-processing systems are added to this basic equipment.

Deck Equipment: The ship's original cargo booms and winches (one 10-ton, two 5-ton, four 3-ton) have been supplemented with one 10-ton A-frame, one 1-ton stern frame, one 1-ton hydraulic telescopic crane, three hydraulic winches, one with interchangeable drum, to take wire ropes or electric cables for underwater cameras, transducers, arrays, etc., and one precise-speed winch that can be remotely-controlled from the main laboratory for the handling of CTD or TDS profilers.

A Pellegrini towed array winch, located in the stern area, has a variable speed control and level wind. The drum for this winch is 12.1 ft./3.7 m. wide, with a circumference of 20.3 ft./6.2 m.

Two other winches on the stern include a small winch with a drum approximately 3 ft./0.9 m. wide by 1.25 ft./0.4 m. diameter and a SACLANT-built winch with cradle and slide for handling the new SACLANT-built towed sound source. This latter winch is fitted with slip-rings and has a drum 6.3 in./16 cm. wide and a

Narrative Description (Cont'd):

3-in./80-cm. inner diameter and an outer diameter of 47 in./120 cm. The drum has the capacity for carrying 1640 ft./500 m. of 3/4-in. wire rope and is provided with a variable speed level wind.

All deck operations at the stern can be monitored in the laboratory or on the bridge by remote TV.

MARIA PAOLINA G. is exceptionally well supplied with electronic measurement and recording instrumentation, including digital computers and peripherals. The equipment arrangement within the main Laboratory, one level below the main deck level, at the time of the survey is given in Figures 7-10(a), 7-10(b), and 7-10(c).

The space just forward of the main laboratory contains the power amplifiers required for driving acoustic sources used in the research program. Included in this area is an:

Instruments Inc.
Mod. L50
Power Amplifier
Frequency Band -- 100 kHz
Pulsed Power Output -- 16.5 kW
CW Power Output -- 6.5 kW
Max Current -- 3.5 amps
Max Voltage -- 1824 volts

Instruments Inc.
Mod. L20
Power Amplifier
Frequency Band -- 200 Hz - 80 kHz
Pulsed Power Output -- 6.5 kVA
at 10% Duty
CW Power Output -- 2.6 kW
Max Current -- 18 amps
Max Voltage -- 1600 V rms

In a separate cabinet is a set of four very quiet power amplifiers. (See Figure 7-11.)

Instruments Inc.
Power Amplifiers
Mode. DA16
Can be operated as: four 12.5 kW amplifiers
two 25 kW amplifiers
one 50 kW amplifier

Located in the same area is a large Electronic Control Corp. (Delta) air-cooled dummy load for use with the above amplifiers or with other amplifiers that might be brought onboard for a specific test.

The SACLANTCEN navigation laboratory is located one level below the main laboratory and includes the instrumentation indicated in Figure 7-12.

R/V ALLIANCE:

The Muggiano shipyard, which lies midway between La Spezia and Lerici, was visited on 9 September 1985. At the time, the intended replacement for the MARIA PAOLINA G. was under construction in this yard. It was then identified as Hull #921, but has since been officially named the ALLIANCE. ALLIANCE was launched on 9 July 1986.

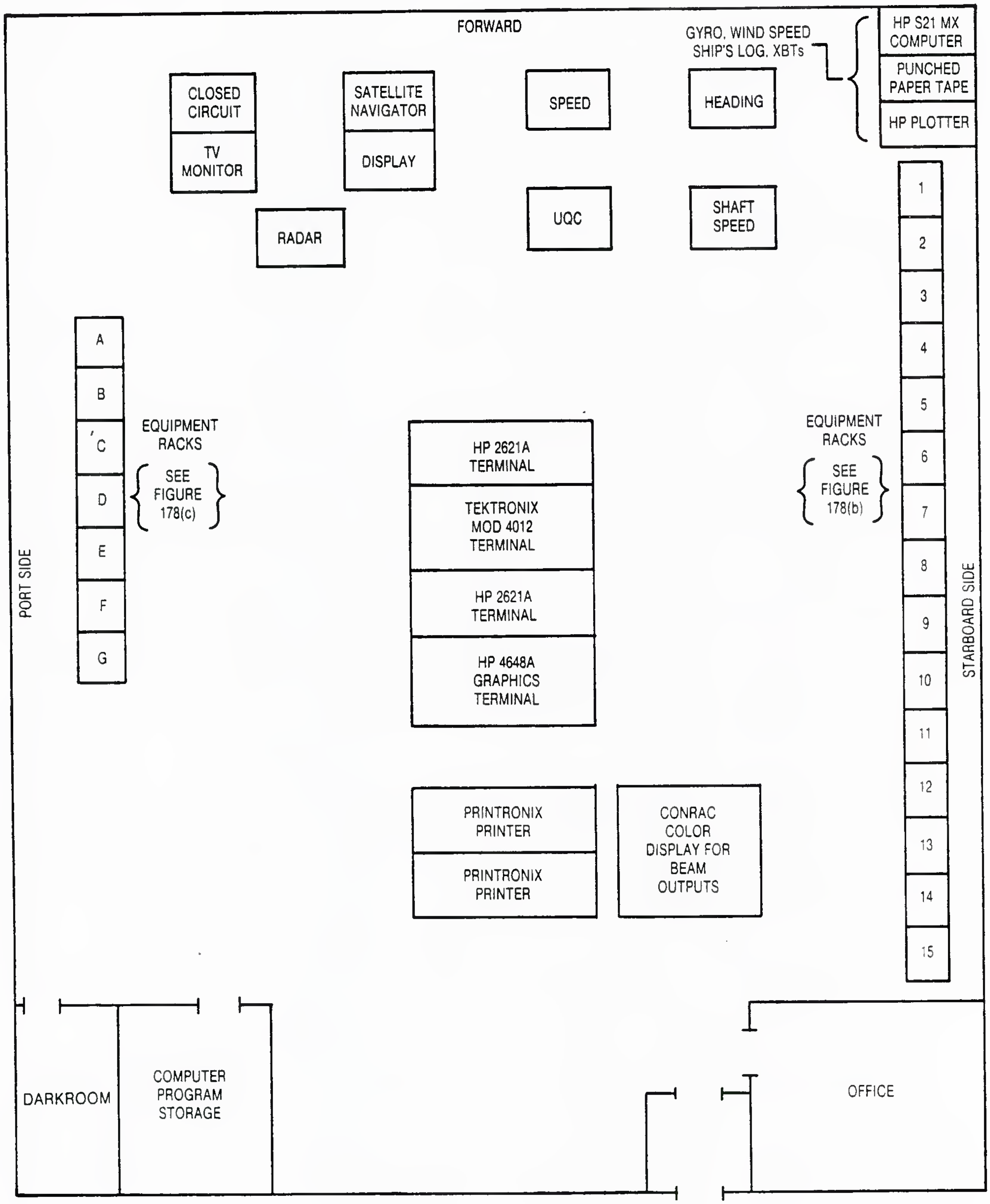

Figure 7-10(a). MPG Main Laboratory: Typical Layout

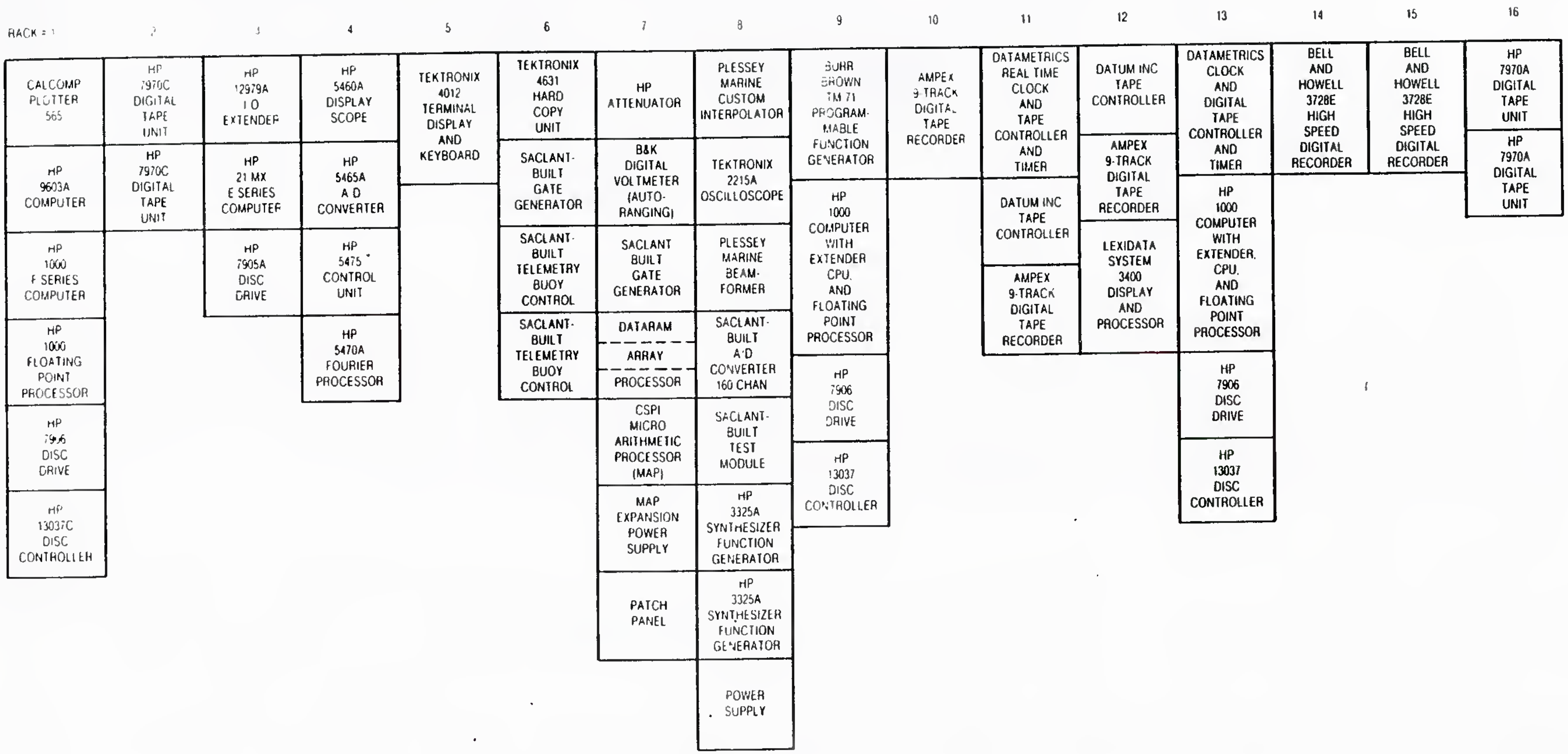

Figure 7-10(b). MPG Main Laboratory: Starboard Side Instrumentation Racks, Typical Layout

RACK A	B	C	D	E	F	G
CALCOMP 565 PLOTTER	HP STRUCTURED DYNAMICS ANALYZER 5423A	COMMUNICATIONS TRANSCEIVER SHIP/SHIP SHIP/SHORE	ANNALOG BEAMFORMER 20 CHAN.	PROGRAMMABLE FILTERS 32 CHAN.	TRANSFORMERS (SIGNAL INPUT FOR TOWED OR VERTICAL ARRAYS)	RECEIVER FOR COMPASS HEADING
HP 9603A COMPUTER	ANALYZER DISPLAY AND TAPE CASSETTE	RANGE TELEMETRY TRANSMITTER	PATCH PANEL	PROGRAMMABLE FILTERS 32 CHAN.	TRANSFORMERS (SIGNAL INPUT FOR TOWED OR VERTICAL ARRAYS)	RECEIVER FOR FORWARD DEPTH SENSOR
HP 1000 F SERIES COMPUTER	ANALYZER KEYBOARD	RANGE TELEMETRY TRANSMITTER	B&K 2305 LEVEL RECORDER	WAVETEK MOD. 171 SYNTHESIZER/ FUNCTION GENERATOR	SIGNAL CONDITIONER	RECEIVER FOR AFT DEPTH SENSOR
HP 1000 FLOATING POINT PROCESSORS	HP 54470B DIGITAL FILTER	ELIND SERIES RADIO DC POWER SUPPLIES	B&K 2305 LEVEL RECORDER	HP 3582A SPECTRUM ANALYZER	SIGNAL CONDITIONER	HP 141A OSCILLOSCOPE
HP 7906 DISC DRIVE	HP 54410A A/D CONVERTER		PATCH PANEL	HP 85 KEYBOARD, DISPLAY, PRINTER, AND CASSETTE DRIVE	HP 3300A FUNCTION GENERATOR	HP 5233L COUNTER
HP 13037C DISC CONTROLLER			MONITOR SPEAKER AND AMPLIFIER		DC POWER SUPPLY FOR VERTICAL OR TOWED ARRAYS	PAPER RECORDER 2-CHAN
						PAPER RECORDER 2-CHAN
						DC POWER SUPPLY FOR VERTICAL OR TOWED ARRAYS

Figure 7-10(c). MPG Main Laboratory: Port Side Instrumentation Racks, Typical Layout

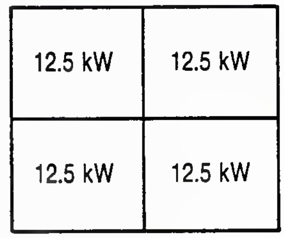

Figure 7-11. Arrangement of DA16 Instruments Inc. Power Amplifier Set

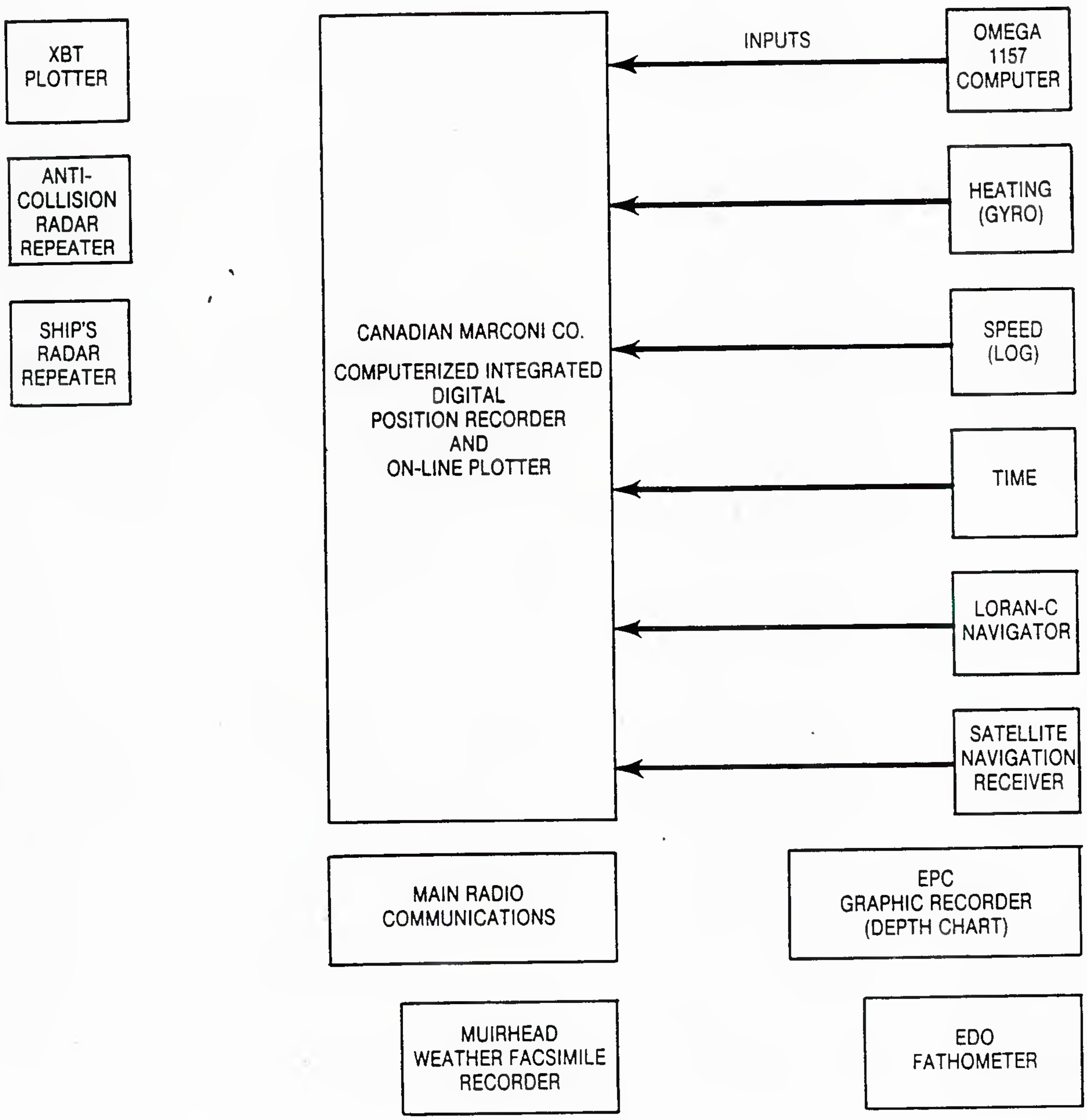

Figure 7-12. Instrumentation Arrangement in SACLANTCEN Navigation Laboratory

Narrative Description (Cont'd):

Instrumentation functionally similar to that now onboard the MARIA PAOLINA G. described earlier will be used aboard the ALLIANCE.

The principal characteristics of the vessel are listed below.

Length: 305.4 ft./93 m.
Beam: 49.9 ft./15.2 m.
Draft: 16 ft./4.9 m.
Full Load Displacement: 2920 tonnes
Gross Tonnage: 3180 tonnes
Fuel Oil: 11,119.5 $ft.^3$/315 $m.^3$
Lube Oil: 176.5 $ft.^3$/5 $m.^3$
Fresh Water: 100 tonnes
Shaft Power (Max Continuous): 2970 kW
Sustained Sea Speed: 16.3 knots
Range at 12 knots: 8000 nmi.

Accommodations will be provided for a total complement of 50, consisting of 10 officers, 20 crew, and a scientific staff of 20.

The vessel will be provided with twin rudders and with twin screws, 5-bladed and highly skewed. The screws will be adjustable in either of two positions: a) 16.3 knots top speed; or b) 20-ton towing (12 knots maximum).

Other features of the ALLIANCE include the fact that the propeller shafts are drilled for possible eventual Prairie installation, it is supplied with a passive roll tank and will have a variable pitch tunnel bow thruster capable of 280 hp at constant speed.

Major deck equipment on the fantail will include a large U-frame which will cover the entire stern, and which can be used in conjunction with a large cascade winch. The winch base covers an area 19.7 x 19.7 x 19.7 ft. high/6 x 6 x 6 m. high. The winch weighs approximately 65 tons and will provide a 50-ton pull.

There are in addition on the stern two smaller winches and two cranes, 2 XBT launchers and facilities to accommodate two containers with dimensions of 8 x 10 x 20 ft./2.4 x 3 x 6.1 m.

In the forward deck work area, there is an articulated crane, a large A-frame with sliding sheave, a Data winch with a pull of 35,200 lb./16,000 kg., and a drum winch with a 6,600-lb./3,000-kg. pull.

There is also an oceanographic winch in the oceanographic winch room with a 49.2-ft./15-m. telescopic arm located on the starboard side of the weather deck with a pull of 2,200 lb./1,000 kg.

The companionway on the weather deck on the port side of the ship is extra wide and runs the entire length of the vessel.

Narrative Description (Cont'd):

There are two propulsion diesel generators and one auxiliary propulsion generator with the following characteristics.

2 main propulsion generators	AC, 3 Ø, 60 Hz, 660 V, 1800 kW
1 auxiliary propulsion generator	AC, 3 Ø, 60 Hz, 440/260 V, 1000 kW

This AC supply must then be converted to a suitable DC voltage for the two propulsion motors which are described as:

DC, 750 VDC, 1470 kW, 130/160 rpm

An auxiliary 1500 kW gas turbine generator is also located on the 03 level.

Electrical power for use other than propulsion is obtained from: three 440 V, 60 Hz, 450 kW generators; one 440 V, 60 Hz, 600 kW generator; or a 1050 Ahr, 220 V DC battery bank.

Silent ship power will be derived from a silent ship 1500 kW gas turbine generator. Power for ultra-quiet ship operations will be obtained from the 220 V battery bank. Ultra-quiet condition can be maintained nominally for one hour.

A helicopter transfer area (not for landing purposes) is located on the after portion of the 01 level.

The vessel will also be supplied with a wet lab, a diver's shop, an amplifier room, ample laboratory spaces, and a large computer area.

Finally, the entire ship will be air-conditioned.

A photograph of the vessel is shown in Figure 7-13, and a line drawing of the exterior of the ALLIANCE can be seen in Figure 7-14.

Figure 7-15 is a longitudinal section of the vessel.

The arrangement of spaces within the ship is shown in Figure 7-16.

Further details concerning ALLIANCE can be obtained by writing the Director of SACLANTCEN at the address given earlier.

Figure 7-13. ALLIANCE

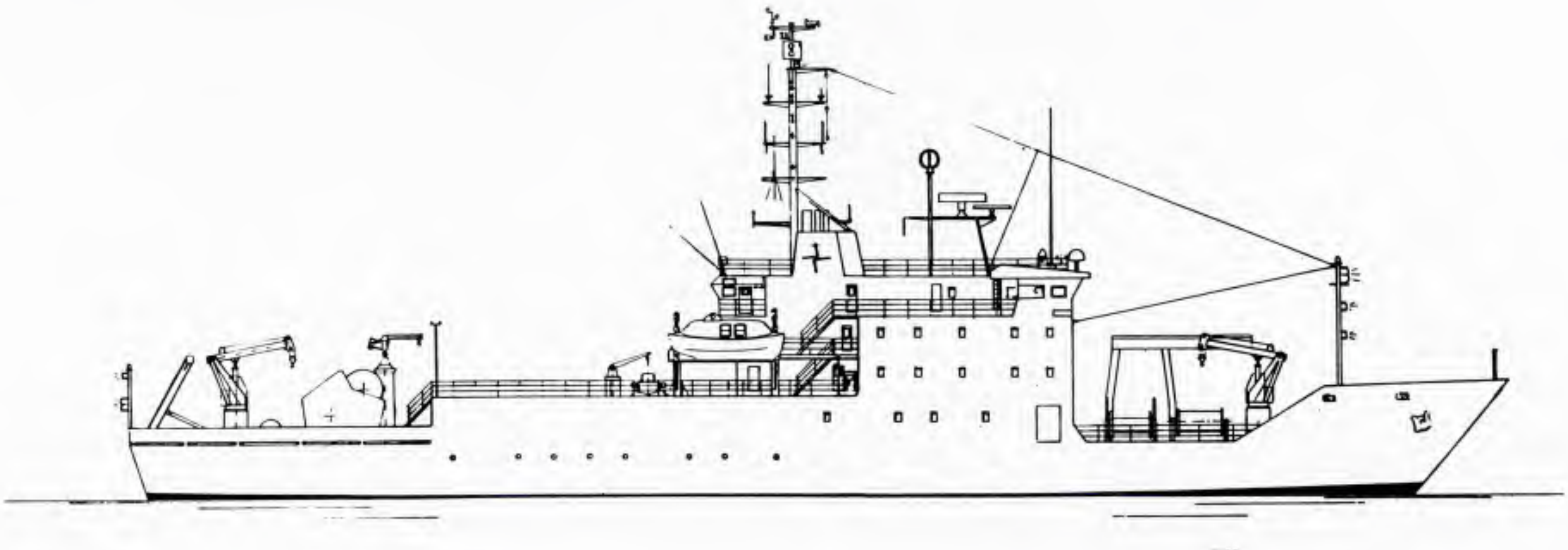

Figure 7-14. Exterior of ALLIANCE

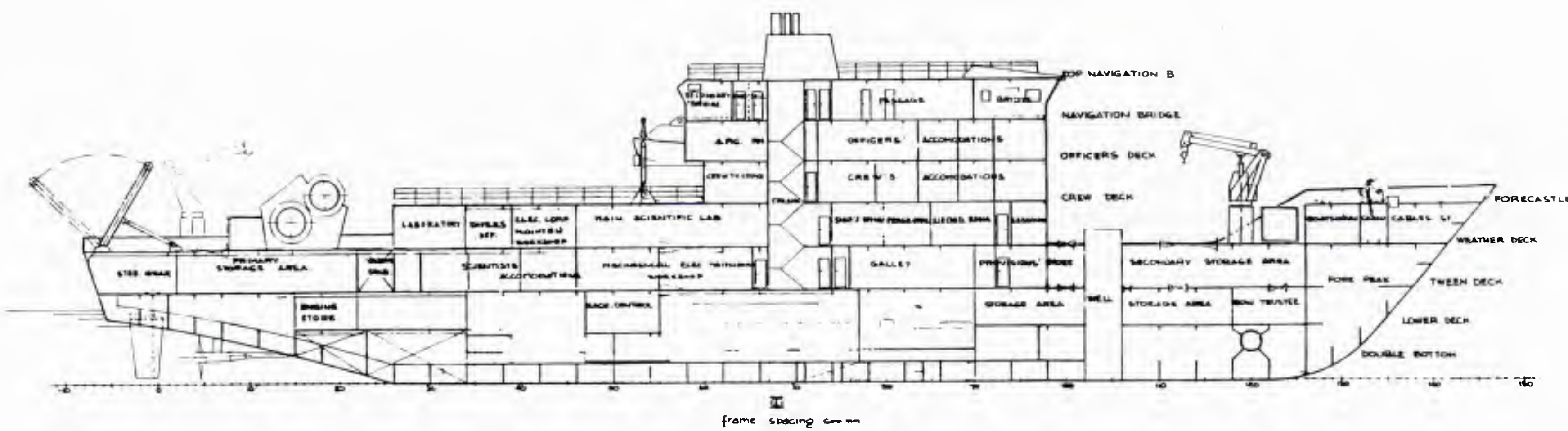

Figure 7-15. Longitudinal Section of ALLIANCE

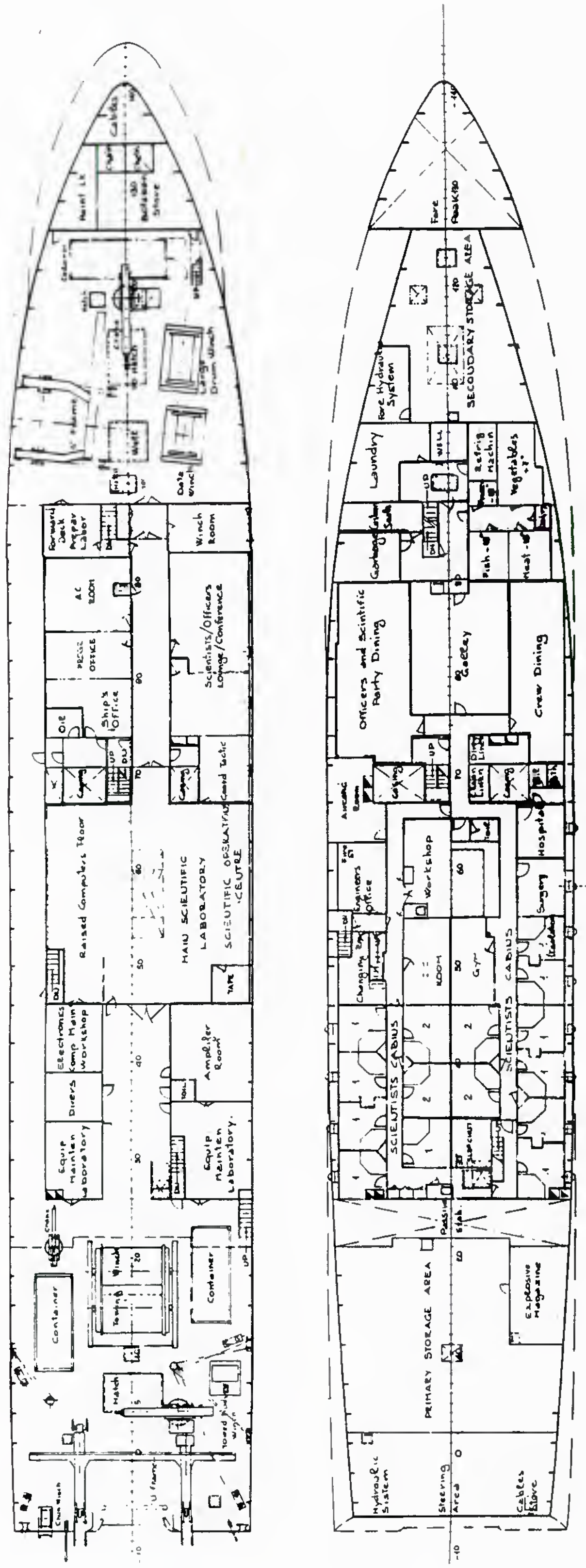

Figure 7-16. Space Arrangement in ALLIANCE

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